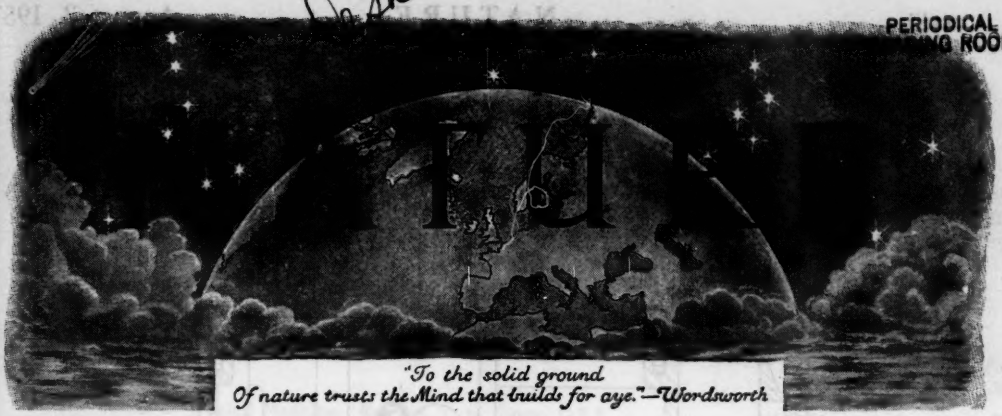
AUG 1 . 19..
PERIODICAL ... ROOM



VOL. 180, No. 4579 SATURDAY, AUGUST 3, 1957 2s. 6d.

C. Baker
OF HOLBORN LTD. EST. 1765

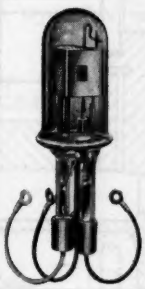
APLANATIC MAGNIFIERS

Cemented triplet lenses yielding well corrected images and flat fields of view. In single pocket mounts, ×8, ×10, ×15. In double mount ×10 and ×15.

Particulars on request:

C. BAKER OF HOLBORN LTD., METRON WORKS
PURLEY WAY, CROYDON, SURREY (CROydon 3845-6-7)
Showrooms: 244 High Holborn, London, W.C.1

VITREOSIL HYDROGEN LAMPS



Provide a source of continuous ultra-violet from 3,700A to below 2,000A., with a smooth spectral distribution.

SPECTROPHOTOMETER CELLS

Vitreosil, pure fused quartz spectrophotometer cells are available, matched or unmatched, in rectangular or cylindrical form, with open tops or stoppered.

We also manufacture an extensive range of Vitreosil Industrial Ware.

THE THERMAL SYNDICATE LTD.
P.O. Box No. 6, Wallsend, Northumberland. Tel: Wallsend 6-3242
London: 12-14 Old Pye St., Westminster, S.W.1. Tel: ABBey 5469

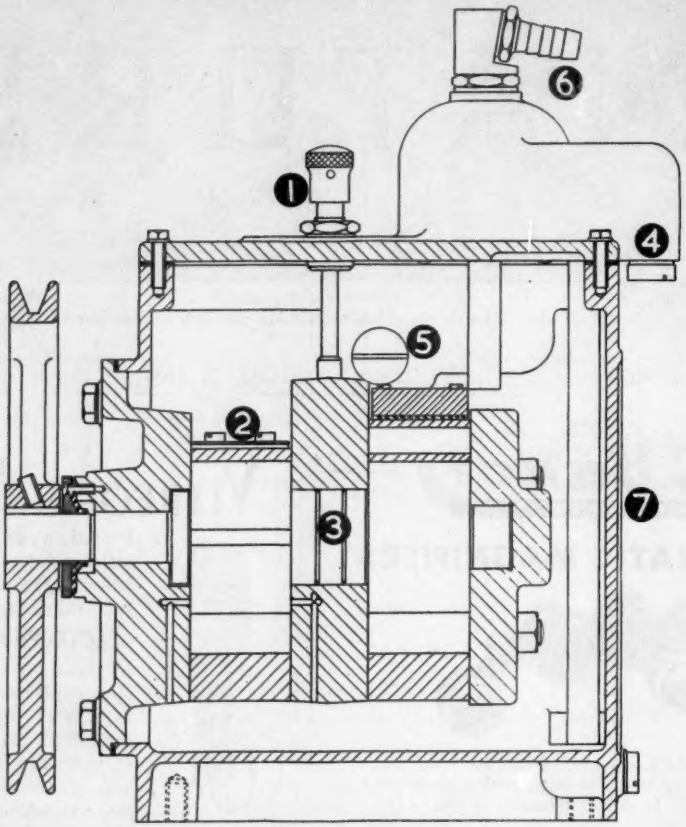
Chamber size 18" × 18" × 16" deep.

THE NEW
BTL
WIDE RANGE OVEN
50°C — 300°C

A hot air convection oven
A fan circulated closed oven
A forced draught oven
Will achieve conditions required by B.S. 2648

Full particulars and price on request

BAIRD & TATLOCK
(LONDON) LTD.
Scientific Instrument Makers
CHADWELL HEATH · ESSEX · ENGLAND



"SPEEDIVAC" VACUUM ROTARY PUMPS

Can't be HEARD – but there's much talk about these features!

1 **AIR-BALLASTING DEVICE** for handling large throughputs of vapour contaminated gases without affecting the high vacuum performance.

2 **GHOSTLY . . . SILENT RUNNING** without sacrifice to the high vacuum performance following exhaustive research into noisy pumps.

3 **AN INGENIOUS PATENTED LUBRICATION SYSTEM** for two-stage pumps maintains the oil for the high vacuum stage free from volatiles, etc., resulting in a far better vacuum performance even under contaminating conditions.

4 **PRESSURE DRAINAGE** gives quick non-messy oil drainage.

5 **ANY-ANGLE-VISION OIL LEVEL SIGHT GLASS.**

6 **DOWNWARD POINTING AIR-VENT** enables any condensation to be drained away from the pump.

7 **REDUCED WEIGHT AND CLEAN APPEARANCE** of pump provided by light alloy die-cast box.

8 **VALUABLE ACCESSORIES** including non-return valves, to protect the system against pump oil, anti-vibration mountings, inlet and outlet catchpots, oil mist filters, traps, condensers, etc.

9 **SPECIALLY PREPARED** corrosion inhibited oils now vailable for extra pump protection.

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

BRANCHES: GLASGOW · TORONTO & MILAN

AGENTS THROUGHOUT THE WORLD

NATURE

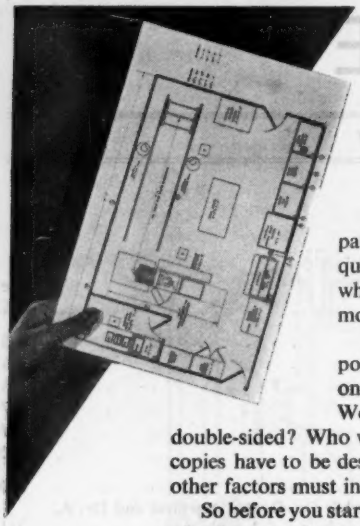
No. 4579 SATURDAY, AUGUST 3, 1957 Vol. 180

CONTENTS

	Page
Training of Medical Students	205
The London School of Tropical Medicine. By Prof. T. H. Davey, O.B.E.	205
Frequency Modulation in Radio. By Dr. R. L. Smith-Rose, C.B.E.	206
Recent Advances in Science. By G. R. Noakes	206
Thermodynamics of Biological Synthesis. By Dr. Herbert Gutfreund	207
Dairy Plant Control. By Dr. L. F. L. Clegg	207
Bases of Induction. By D. V. Lindley	208
The Research Institute (Animal Virus Diseases). By Dr. Ian A. Galloway	210
Solar Granulation and its Observation from a Free Balloon. By Dr. D. E. Blackwell, Dr. D. W. Dewhirst and Dr. A. Dollfus	211
Avoidance of Collision at Sea and in the Air. By Captain F. J. Wylie, R.N.(retd.); D. O. Fraser	213
News and Views	216
British Steel Castings Research Association. By Dr. A. H. Sully	221
British Cast Iron Research Association. By Dr. J. G. Pearce, C.B.E.	222
Organization of the Meteorological Office	223
Water Resources of Great Britain. By Prof. W. G. V. Balchin	223
The Wellcome Trust	224
Surface Activity. By Dr. J. H. Schulman, O.B.E.	225
Studies on Fertility. By Dr. G. I. M. Swyer	226
Agriculture at Cambridge. By Dr. E. C. Humphries	227
Night-Vision Efficiency. By H. B. Barlow	228
Statistical Analysis of a Random, Moving Surface. By A. M. Walker	228
Variable Stars in the Magellanic Clouds	229
Pollen in Terrestrial Soils	229
Congenital Porphyria in Bovines: First Living Cases in Britain. By Prof. E. C. Amoroso, F.R.S., R. M. Loosmore, Prof. C. Rimington, F.R.S., and B. E. Tooth	230
Difference and Derivative Spectra. By Dr. A. E. Martin	231
An Effect of *p*H on the Uptake of Salt by Plant Cells. By R. G. Hurd and Dr. J. F. Sutcliffe	233

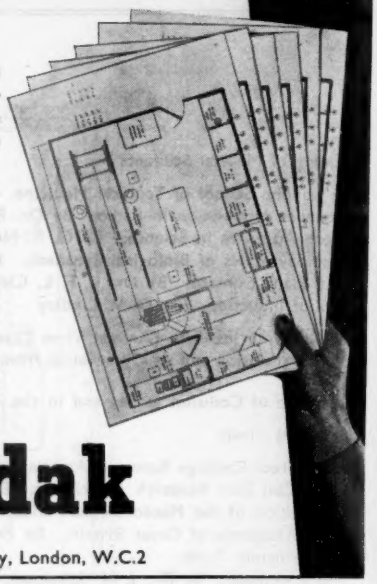
Letters to the Editors:

A New Type of Nitrogen-fixing Bacterium.—A. B. Roy and M. K. Mukherjee	236
An Albino Strain of the Desert Locust.—Philip Hunter-Jones	236
Sclerotization and Melanization: Two Independent Processes in the Cuticle of the Desert Locust.—Dr. S. R. A. Malek	237
Action of Diaphanol on Arthropod Cuticles.—J. Kennaugh	238
Surviving Rat Skin Grafts in Mice.—O. Brocades Zaalberg, O. Vos and D. W. van Bekkum	238
Amino-Acid Composition of Adult and Fœtal Myoglobin of the Cow.—R. Timmer, H. J. van der Helm and Dr. T. H. J. Huisman	239
Myoglobins from Sheep Homozygous for Different Hæmoglobin Types.—H. J. van der Helm, R. Timmer and Dr. T. H. J. Huisman	240
Abnormal Hæmoglobins in Monkeys.—G. F. Jacob and Dr. N. C. Tappen	241
Occurrence of a Cardio-active Principle in Spleen—L. B. Cobbin and Prof. R. H. Thorp	242
Hydroxyproline and Thermal Stability of Collagen.—Dr. D. A. Hall and Dr. R. Reed	243
Catechol Compounds in Rat Tissues and in Brains of Different Animals.—Dr. K. A. Montagu	244
Conversion of Pyruvic Acid to Alanine in the Silkworm Larva.—T. Fukuda	245
Activation of Polynucleotide Phosphorylase by Salts.—Roland F. Beers, jun.	246
Anthocyanidins of *Lochnera rosea*.—Dr. W. G. C. Forsyth and N. W. Simmonds	247
Characterization of 2-Amino-2-Deoxy-D-Altrose.—Dr. A. B. Foster, Prof. M. Stacey, F.R.S., and S. V. Vardheim	247
Metamict Tantalite from Western Australia.—Prof. C. Osborne Hutton	248
Dependence on Oxygen and Temperature of the Sensitivity of Broad Bean Roots to γ-Radiation.—G. J. Neary	248
Reaction of Carbon Monoxide with Evaporated Barium Films.—R. N. Bloomer	249
State of Iodine in Sea Water.—T. I. Shaw and L. H. N. Cooper	250
Colorimetric Estimation of Manganese.—W. V. Single	250
Use of Wooden Boxes for Breeding Mice.—Joyce L. Bloom, Dr. W. Lane-Petter and G. Porter	251



Do you need

one copy – or several?



Every organisation has its own particular document-copying requirements, so you alone can decide which copying method would be most suitable for your purposes.

For example, is time a very important factor? Would you require one copy of a document, or several? Would originals be single-sided or double-sided? Who would use the equipment? Would copies have to be despatched immediately? These and other factors must influence your choice.

So before you start buying, get in touch with Kodak, who have an immense amount of document-copying experience behind them. They will provide you with a great deal of information that should help you to select the most suitable method for your particular needs.

Kodak

Kodak Limited, Industrial Sales Division, Kodak House, Kingsway, London, W.C.2

DIRECT READING pH METER

MODEL 23A

This high-grade laboratory pH Meter is one of the most widely used instruments in electrochemical research.

Some 50 different types of electrodes are available for pH, redox and micro analytical work. Stable to 0.02 pH with a B.S. precision grade meter and a recorder output.

E·I·L **the pH people**

ELECTRONIC INSTRUMENTS LIMITED · RICHMOND . SURREY . ENGLAND

RIChmond 5656

E.7

TRAINING OF MEDICAL STUDENTS

THE General Medical Council is charged by Act of Parliament with the supervision of medical education in Britain, and is empowered to appoint visitors and inspectors to report on the quality and content of the training afforded by medical schools, and on the quality and standard of the examinations which punctuate the medical student's career. A number of "Recommendations as to the Medical Curriculum" were published by the Council in 1947, and were referred to at the time in a leading article in *Nature* (160, 482; 1947). Two main criticisms which these recommendations have evoked over the past ten years is that they were too detailed and precise, and that they left insufficient scope to licensing bodies and schools to vary their curricula and requirements as experience dictated. The biggest stumbling-block to independent action was that the whole period of professional study—five academic years—was divided into a period of pre-clinical studies, a transitional period of studies leading to the clinical course, and a period of clinical studies, for each of which a minimum duration was recommended. A new set of recommendations has now been issued, very much shorter than the last, which departs from these temporal stipulations. While the Council insists, as before, on a minimum of five academic years for the full course, it does not lay down how the time which the medical student has to devote to all his professional studies should be subdivided between various subjects. This is now left to the initiative of licensing bodies and schools. Similarly, the new recommendations do not lay down, as a requirement, the number of separate subjects in which medical students should be examined, leaving it again to the authorities in each medical school, and to the licensing bodies, to decide whether or not certain of them can be combined in a single examination.

There are a number of other differences between the older recommendations and the new and shorter set by which they are superseded. One of the most interesting is that the Council has revoked a recommendation which has prevailed hitherto, and which no doubt reflected a practice that was centuries old, that each medical student should dissect the whole body during the period of his anatomical studies.

For the rest, the recommendations are in the same general terms as before. The Council continues to emphasize the need to reduce the congestion of the curriculum. But only the individual teacher can reveal what value there is in admonitions to eliminate unnecessary detail and specialization from the curriculum; in exhortations to integrate its various sections; in counsel that it is better to educate than to instruct; or in a generalization that the critical study of principles develops a capacity for independent thought far better than does an insistence on the memorization of factual data. Judging by previous results, the average teacher of medicine is somewhat allergic to these pieces of advice.

THE LONDON SCHOOL OF TROPICAL MEDICINE

History of the School of Tropical Medicine in London (1899–1949)

By Sir Philip Manson-Bahr. (London School of Hygiene and Tropical Medicine Memoir No. 11.) Pp. xiv+329. (London: H. K. Lewis and Co., Ltd., 1956.) 50*s*. net.

THE appearance of a new volume in the series of memoirs from the London School of Hygiene and Tropical Medicine is an important event in the literature of tropical medicine. This historical record of the London School from its foundation until 1949 maintains the high standards set by the preceding volumes. It is particularly valuable in that it is written by one who joined the staff of the School in 1909 and remained with it until he retired from the post of director of the Clinical Division in 1947. He therefore knew intimately the great figures who created and built up the School over its first fifty years, and he was personally implicated in the development of its clinical side.

The book is divided into four sections. The first, the historical section, begins by sketching the situation in regard to tropical medicine in the last decade of the nineteenth century. Sir Patrick Manson had returned from the Far East in 1893 and was practising in London, and in 1897 he was appointed medical adviser to the Colonial Office. The Prime Minister was so impressed by his description of the backward state of knowledge of tropical diseases that in 1898 he addressed a circular letter to the relevant authorities in Great Britain suggesting that facilities should be provided for training future medical officers of the Colonies in this subject. Preparations were immediately made for creating Schools of Tropical Medicine in Liverpool and London, and these were opened to students in 1899, the London School in the hospital of the Seamen's Hospital Society at Greenwich. The expansion and development of the London School and its contributions to the advancement of knowledge are then described. The buildings at Greenwich became too small, and in 1919 the School moved to Endsleigh Gardens, where again the accommodation soon became inadequate. In 1926 the Rockefeller Foundation offered a gift of two million dollars to the proposed new School of Hygiene in London on condition that it incorporated the London School of Tropical Medicine. This offer was accepted, and in 1929 the School of Tropical Medicine was integrated with the School of Hygiene in its present buildings. Further chapters are concerned with such subjects as the library, the museum, and the important malaria experiment in 1900 in the Roman Campagna which demonstrated that malaria could be prevented by protecting man from the bites of mosquitoes.

The author then gives a series of short biographies of members of the staff and workers at the School since its formation. Each presents briefly, in addition to a catalogue of scientific attainment, an intimate picture of its subject enlivened by the author's personal memories. They include not merely those whose names are famous, but also all who taught and helped in research, including assistant staff. The only biography missing is that of the author himself, and that has been contributed in a preface by Dr. Charles Wilcocks. A detailed diary follows,

which records in chronological order all the important events in the history of the School, and the book concludes with an appendix giving accounts of the School's research expeditions, a note on the collected papers of the staff, lists of prize-winners, a copy of the syllabus adopted in 1925, and a résumé of the clinical work of the School during 1920–39.

This volume will prove of great interest to all who are concerned with tropical medicine because it is a history of the development of a large part of our knowledge of tropical disease. Past students will recapture in its pages the atmosphere they knew. It is written in a highly readable manner with many amusing anecdotes and is magnificently produced with numerous photographs of persons and places.

T. H. Davey

FREQUENCY MODULATION IN RADIO

Frequency Modulation

By L. B. Arguimbau and R. D. Stuart. (Methuen's Monographs on Physical Subjects.) Pp. vii+96. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1956.) 8*s*. 6*d*.

Frequency Modulation Engineering

By Christopher E. Tibbs and G. G. Johnstone. Second edition, revised. Pp. xii+435. (London: Chapman and Hall, Ltd., 1956.) 45*s*. net.

IN the frequency modulation system of radio signalling, the frequency of the carrier waves is varied while the amplitude is maintained constant. The theoretical principles of frequency-modulated waves and the resulting spectrum of the radiation have been known for well over a quarter of a century; and the possibilities of an improved signal-to-noise ratio from the system were demonstrated at least twenty years ago. But during this period much controversy has taken place over the relative merits of frequency and amplitude modulation, particularly for broadcasting purposes. The introduction of very high frequencies into practical transmission has greatly increased interest in this subject.

The monograph by Messrs. Arguimbau and Stuart forms a useful introduction to the frequency modulation system as a means of reducing the effect of extraneous disturbances during radio transmission. After a theoretical chapter on the nature of frequency modulation, the principles and circuit arrangements of suitable transmitters and receivers are dealt with. Then follows an important chapter on interference and the means of reducing this; and a brief consideration of the application of the system to television concludes the book. The addition of a few references at the end of each chapter helps to make this monograph a useful introduction to the whole subject.

The larger work by Messrs. Tibbs and Johnstone constitutes a major revision and expansion of an earlier edition of the book by the first author; and it is intended to provide a concise survey of the application of frequency modulation to radio engineering. As stated in a foreword by Dr. K. R. Sturley, head of the B.B.C. Engineering Training Department, the exploitation of frequency modulation for broadcasting was delayed in Britain by the War; but with the Government's decision, in July 1954, to inaugurate a very high frequency sound broadcasting service, much greater interest was aroused in the subject.

After introductory chapters on the principles of frequency modulation, the structure of electrical noise and its suppression as a source of interference in radio reception are considered in detail. Furthermore, since the modern application of frequency modulation is to carrier wave frequencies greater than 30 Mc./s. (wave-lengths less than 10 metres), the authors justifiably devote separate chapters to the propagation of very short waves, and to the aerial systems with which they are used. These chapters are important in enabling the engineer to understand how distortion of the audiofrequency signals can arise due to wave reflexion effects; they also direct his attention to the care necessary in the design of receivers. The second half of the book deals with the principles and practical design of transmitters, receivers and measuring instruments for frequency modulation systems, with a brief indication of their application to services other than broadcasting. The selected references at the end of each chapter appear to indicate that most of the important literature on the subject of frequency modulation is to be found in American journals.

The publication of this book will therefore help to redress the balance; its production is a credit to both authors and publishers, and it will form a timely and most useful guide to those interested in any of the several engineering aspects of the subject.

R. L. Smith-Rose

RECENT ADVANCES IN SCIENCE

Recent Advances in Science

Physics and Applied Mathematics. Edited by Prof. Morris H. Shamos and Prof. George M. Murphy. Pp. xii+384. (New York: New York University Press and Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 7.50 dollars.

THE contributions to this excellent survey were originally given as lectures at a symposium arranged in 1954 by the Division of General Education of New York University, where a number of the leading physicists in the United States explained the recent advances in their own fields to a non-specialist gathering of scientific workers. The articles, which deal with work that was in progress at the time and ideas which were then developing, as well as with achievements already accepted, are pretty well up to date with things at present. Thus, H. A. Bethe mentions the plans then being made by Reines and Cowan to detect the neutrino by inverse beta-decay; C. H. Townes explains the principle of the 'maser' (as yet unnamed), being rather guarded as to whether it will eventually work usefully; and L. J. Haworth, looking forward into the next decade, completes a discussion of the alternating-gradient synchrotron with a picture of the Brookhaven machine when happily settled on its estate.

There is a well-illustrated account by N. F. Ramsey of experimental work on neutron physics; W. Shockley gives a fairly elementary but full description of transistor physics; and R. M. Bozorth on ferromagnetism mentions many interesting recent applications of the ferrites and other new materials. On the more theoretical side, I. I. Rabi discusses

atomic structure, emphasizing the importance of recent work on positronium; and F. G. Brickwedde explains the curious physical and statistical properties of the quantum liquid, helium II. V. F. Weiskopf analyses the complicated pattern of the elementary particles, and forecasts more to come as cosmotron work in the ultra-high energy range develops. There are three contributions of a more general type—Richard Courant on the many applications of numerical methods, with the strong-focusing synchrotron, weather forecasting, and flood control as typical examples; P. M. Morse on the adaptation of operational research to linear programming in business, and the uses of the Monte Carlo method; and E. U. Condon, on physics and the engineer, directing attention to the shortage of high-school science teachers. This last appears to be a feature of the times, and not restricted to any one country; one wonders if it is really the only problem that is quite unapproachable by the methods of operational research, for there must be some way of averting the impending academic dust-bowl.

Each article starts with a brief elementary introduction, and the general reader might gain from the book a good idea of what physicists have been doing recently, more particularly in the United States. But it is primarily intended for the scientific reader who wishes for a broad and fairly detailed picture of current progress. He will find it outstandingly useful.

G. R. Noakes

THERMODYNAMICS OF BIOLOGICAL SYNTHESIS

Some Principles of Energetics in Biochemical Reactions

By Prof. Irving M. Klotz. Pp. vii+64. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1957.) 3 dollars.

SEVERAL selected topics of thermodynamics are of importance for the interpretation of the results of biochemical experiments. A closer understanding of their principles is helpful to biochemists for such practical purposes as well as for a strategic view of problems of the maintenance and development of biological systems. Only 20–25 years ago there were still lively disputes among eminent scientists as to whether the laws of thermodynamics are strictly applicable to biological systems. Some suggested that evolution or man's intellect had special 'Maxwell demons' to enable them to contravene the second law of thermodynamics. Good expositions of the thermodynamics of open systems and of the relations between information (intellect) and entropy have converted most people to the only acceptable contention that the laws of thermodynamics are applicable to biological phenomena.

Classical chemical thermodynamics was developed in a form most suitable for the interpretation of the results of experiments of isolated chemical systems at equilibrium and under standard conditions. Biochemical reactions in a cell, or in one of the many multi-enzyme systems used for the study of synthetic processes, are not in equilibrium but in a steady state. The composition of the solution must be suitable for the reaction, and cannot be varied to suit the convenience of physical interpretation. Thermodynamic properties of substances of biochemical importance can, of course, be determined under standard equilibrium conditions, but a study of the special aspects of the energetics of biochemical reactions requires the consideration of special conditions.

In Dr. Klotz's little book none of these problems of importance to biochemists is considered. He presents the most elementary exposition of thermodynamics I have ever seen, and illustrates it with examples from reactions of protein molecules and of biochemically important esters. As such this book should be very useful for students taking a first-year course in a biological subject; no previous knowledge of physics or physical chemistry is required, but the relevance of phosphate transfer should be understood. Even for such a junior reader the first few pages are somewhat unsophisticated, and it is my experience that somewhat greater rigour in the derivation of thermodynamic functions makes it easier for students to understand and remember them.

Apart from the subject-matter mentioned above, Dr. Klotz gives a good elementary account of the thermodynamic principles of electrode processes, osmotic pressure, sedimentation equilibria and of the molecular-statistical basis of thermodynamics. One must not look to this book for thermodynamic data for the reactions discussed; those given are not carefully chosen nor are adequate references to the literature given. Another very serious omission is that nowhere in the book can one find a discussion of the effect of *p*H on the reactions of charged compounds. Ionizable groups are involved either directly or indirectly in most biochemical reactions and consequently a brief treatment of the relation between dissociation constants, hydrogen ion concentration and chemical equilibria does seem essential. One must point out that the so-called standard free energies quoted for various hydrolysis reactions are only valid at definite *p*H values, which are not quoted in the book.

All these remarks should not be taken as a severe criticism of the book; different readers would expect different topics discussed in sixty-four pages under this title. Unfortunately, most people in Britain will find the price prohibitive at about 4*d*. a small page; surely this is just the sort of book which should be available cheaply between paper covers.

Herbert Gutfreund

DAIRY PLANT CONTROL

Laboratory Control of Dairy Plant

By Dr. J. G. Davis. Pp. xii+395. (London: Dairy Industries, Ltd., 1956.) 30*s*.

LABORATORY control of dairy plant is becoming more essential nowadays with the ever-increasing tendency for larger 'through-puts' of plant. Mistakes which with small plant were unfortunate can now mean a serious economic loss with large plant. Hence strict laboratory control has now become a necessity, and, in consequence, so has a book on the subject.

The author first deals with the purpose of plant control, and underlines the fact that testing must be economic. The principles of cleaning and sterilizing plant are given a chapter as complementary information to the succeeding chapter on methods of assessing the cleanliness and sterility of dairy plant. On p. 19 the author recommends the inclusion of sodium sulphite in a detergent to minimize attack on tin

plant. It might have been helpful if he had pointed out that this should not be included in any detergent for use with sodium hypochlorite. The author, besides giving detailed bacteriological methods, describes simple tests which can sometimes be as useful.

The section on plant control, which is, of course, fundamental to a book such as this, contains details of the operation of conventional pasteurizing and sterilizing plant as well as of later developments such as in-bottle pasteurization and ultra-high temperature heaters. Other types of plant, homogenizers, clarifiers, filters, coolers for milk and also plant for other dairy products, ice cream, evaporated and condensed milk, are also considered, together with the setting and checking of instruments.

Bottles and bottle washers, detergents, sterilants, water and effluents all have separate chapters, in logical sequence. Routine bacteriological, chemical and physical tests dealing with all these aspects are detailed, but all are related in such a manner that it is clear in what circumstances they should be used and how the results of the tests should be interpreted.

Refrigeration and steam raising, and the resultant problem of corrosion are each given chapters, although these can probably be considered as no more than introductions to the subjects. There is a collection of most useful information on volume and weight measurement, trace metal problems, miscellaneous materials and processes, and the book concludes with two chapters on economic and legal aspects, points about which the manager, plant operator and laboratory worker must nowadays have more than passing knowledge.

The text is liberally illustrated with photographs and diagrams; there is an abundance of references in the text, with, in addition, an alphabetical list of references covering eighteen pages.

The author is well qualified to write such a book as this, having worked at a research institute and also in commerce. The book is obviously written as much for the manager as the laboratory staff, and the fundamentals could apply to other food industries. Indeed, this handbook serves a most useful function, is pleasingly got up, and contains very few textual errors.

L. F. L. Clegg

BASES OF INDUCTION

Foundations of Inductive Logic

By Roy Harrod. Pp. xviii+290. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 24*s*. net.

In the preface to his book, Mr. Harrod modestly describes how, as an eminent economist and biographer, he came to be interested in the problems of induction, and how eventually he came to believe that he had a contribution to offer to their solution. The outcome is the present book, which attempts to place inductive logic on as firm a basis as deductive logic, without the use of such principles as the 'uniformity of Nature' or the 'law of universal causation'; and without reference to prior probabilities. The philosophical outlook is that of Hume but without that author's sceptical conclusions.

The introduction is a brief résumé of the problem. The detailed study begins in Chapter 2 with a definition, based on frequency ideas, of probability. Simple induction is considered in the next chapter and a most ingenious argument is introduced to explain the principle of learning by experience: that what has happened in the past will often continue to happen in the future. In essence the argument is that if one is moving through a continuum then one is unlikely to be near the edge of it. A probability can then be assigned to the event that the continuum will continue for at least a proportion $1/x$ of the time that has already been experienced in it. If the derivation contains a hidden use of prior probabilities, then it has been well disguised. Chapter 4 deals with more general induction problems and contains another involved, but highly interesting, discussion of how a probability can be attached to a hypothesis, without any use of prior probabilities. The Heracleitean hypothesis is considered in the next chapter. Chapter 6 discusses the simplicity postulate introduced by Sir Harold Jeffreys and contains a justification for it. The definition of knowledge, memory, the argument for the existence of other sentient beings, are the topics of the next three chapters. The fundamental principles of induction are reconsidered in Chapter 10 in the light of these discussions, and the book concludes with some remarks on the thoughts it is sensible to have about a world lying beyond that to which our senses give us access.

It might have been thought that the author's central problem was one that needed considerable use of mathematical techniques in its treatment. In the preface (p. vi) there is an apologia for the lack of mathematical expression in the argument, but this is directed more towards mathematical logicians than to those mathematicians, usually termed statisticians, who have developed techniques of inductive logic that are in daily use in scientific thinking. Now Mr. Harrod is concerned with philosophical aspects of the problem, and not with its details of application, and has been most successful in putting forward a thesis with no mathematical language. But he has no excuse for ignoring the philosophical aspects of the statisticians' arguments. In fact, only one statistician, Sir Harold Jeffreys, is mentioned throughout the book. The argument used in Chapter 4, and termed 'reversing the consequents', appears to be a special case of the argument of 'confidence intervals' introduced by Neyman. It is true that the notion of a 'deflator' has not received formal mathematical expression by Neyman, but any statistician would be cognizant of the need for it in an application of the method. There are several strong reasons for disliking confidence intervals, and these have not been mentioned in the book. Again, following similar work by von Neumann and Morgenstern in connexion with the concept of utility in economics, Savage has shown that, subject to some mild requirements, any person acting rationally (that is, satisfying these requirements) is in possession of a prior probability. The central problem of probability theory to-day is not how to do away with the prior probability, but to find what prior probability it is that corresponds to the concept of nescience, if this concept has meaning. It may be that Mr. Harrod has, particularly in Chapter 3, produced an argument which might well be capable of answering this last question, though he places the emphasis differently. The book can be warmly recommended to statisticians, but philosophers should beware of the omission of relevant arguments.

D. V. Lindley

Experimental Physical Chemistry

By Prof. Farrington Daniels, Prof. Joseph Howard Mathews, Prof. John Warren Williams, Prof. Paul Bender and Prof. Robert A. Alberty. Fifth edition. Pp. xi+482. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 49*s*.

THE avowed object of this book is the same as that of the 1929 and later editions, namely, "to illustrate the principles of physical chemistry, to train in careful experimentation, to develop familiarity with apparatus, to encourage ability in research". The volume is representative of the teaching of the laboratory course at the University of Wisconsin. Part I contains fifty-nine sections each of which describes an experiment and consists of a short introduction, an account of theory, apparatus, procedure, calculations, practical applications, suggestions for further work and references. It is intended that the experiments should be carried out under the guidance of an instructor. The second part of the volume, occupying pp. 321–469, describes apparatus and techniques, particularly for more advanced work. No claim is made for completeness, and the authors have been guided by their own experiences. This part of the book is not very satisfactory because so many subjects are dismissed in so few words. Thus microscopy is discussed in thirty-two lines and spectroscopy (visible, ultra-violet and infra-red) is described in forty-six lines. However, there are some interesting sections such as that dealing with the use of electronics in physical chemistry (twenty-nine pages). The inside of the front cover gives a list of atomic weights while the back cover carries a table of four-figure logarithms. The first part of this book presents the results of considerable experience in the teaching of practical physical chemistry and staffs of universities may well find here useful suggestions for their practical courses. E. F. G. HERINGTON

Acridines

By R. M. Acheson. With a chapter by L. E. Orgel. (Chemistry of Heterocyclic Compounds: a Series of Monographs, Vol. 9.) Pp. xii+409. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 12.50 dollars.

HETEROCYCLIC chemistry is poorly provided with comprehensive monographs, and this series is designed to provide a detailed treatment of the whole field. This book maintains the high standard set by its predecessors. The anti-malarial and anti-bacterial properties of certain acridines led to an intensive, but somewhat unbalanced, development of acridine chemistry. In Albert's "Acridines", published in 1951, the pharmaceutical aspects are stressed, and the large amount of experimental technique included makes it an invaluable book for the specialist. Acheson, dealing inevitably with much the same information, has adopted a different approach. He has arranged the material in a more logical way; he has emphasized topics of general chemical interest, for example, the mechanism of reactions, and relegated details of individual compounds to a series of extensive and excellent tables. Thus, the book provides lively reading for those interested in heterocyclic chemistry, and also serves as a standard reference text—a rare combination of virtues. Acheson has included an excellent chapter on the acridine alkaloids. This work has its own intrinsic interest, but also illustrates how intensive work on individual compounds illuminates the chemistry of a whole class, in this case the polymethoxy and polyhydroxy acridines. The concise account of the absorption spectra of acridines is well written by Orgel. Some infra-red spectra are reproduced, unfortunately without comment. The text is almost completely free from trivial errors, but the index is not always adequate. M. F. GRUNDON

Dictionary of Microbiology

By Morris B. Jacobs, Maurice J. Gerstein and Prof. William G. Walter. Pp. iv+276. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1957.) 50*s*. net.

ACCORDING to the publishers' note, this dictionary contains some 5,000 entries giving "clear and explicit definitions of terms from the entire field of microbiology". The entries include systematic names and classification data for bacteria (Bergey's nomenclature), moulds, protozoa and viruses together with antibiotics, etc. Spot tests showed that entries were comprehensive and satisfactory in these fields but less good in other subjects normally included in modern microbiology. For example, there is no reference to eclipse phase, latent phase, lysogency, induction, kinetoplast, chemostat, auxotrophe, lecithinase, strepogenin or racemase. Biochemists will find definitions of some chemical terms somewhat superficial: the various amino-acids are listed and described as "involved in the metabolism of micro-organisms", while pyridoxin derivatives are "probably converted to amino-acid decarboxylases". Transforming Principle is referred to pneumococcal-type transformation only; plasmagenes are "genetic determinants in the broadest sense"; an auxanogram refers to study of inhibitors, while an auxanograph refers to utilization of carbohydrate or nitrogen-bearing substances. In general, the dictionary contains much of use to all microbiologists, but is not of great assistance to the expert who requires precise definition of technical terms or elucidation of recent or uncommon words in his own field.

E. F. GALE

A Scientific Sampler

Edited by Raymond Stevens, Howard F. Hamacher and Alan A. Smith. Pp. xviii+413. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1956.) 45*s*. net.

ARTHUR D. LITTLE, Inc., is a research organization in the United States with a large staff devoted mainly to research in the applied sciences. Once a month the organization publishes an *Industrial Bulletin* in which the staff are given opportunities for describing their professional and extra-curricular interests in a form suitable for the lay reader. Over the past thirty years a wide range of topics has been considered, and the editors of the *Bulletin* have now brought a large number of them together to form a fascinating book. Some of the articles are more than twenty years old, but have been brought up to date by the addition of suitable footnotes. The variety of subjects covered is so great that it would need exhaustive treatment to cover them; few aspects of science are unrepresented.

"The Scientific Sampler" is a book for which many specialists have been looking. The articles are brief, clearly written and could be used either for reference or as a bedside book. The editors should be congratulated, not only for their choice in authors, but also for the way they have put the book together.

T. H. HAWKINS

THE RESEARCH INSTITUTE (ANIMAL VIRUS DISEASES)

OPEN DAYS

By Dr. IAN A. GALLOWAY
Director

AN extensive building and development scheme costing something of the order of £1 million has recently been completed at the Research Institute (Animal Virus Diseases) at Pirbright in Surrey. The Institute is engaged on fundamental research on foot-and-mouth disease and the virus which causes it with the object of discovering methods of control and eradication in Britain and overseas. Investigations are also in progress on certain other viruses, for example, vesicular stomatitis and vesicular exanthema, which cause diseases clinically similar to foot-and-mouth disease. All the work is proving of great interest to workers in the wider field of research on human, animal and plant virus infections.

There was an alteration in the administrative arrangements in 1951 when a governing body was constituted. The members are appointed by the Ministry of Agriculture and the Secretary of State for Scotland after consultation with the Agricultural Research Council and the Medical Research Council. In 1956, responsibility for the grant-aiding functions were transferred from the Ministry of Agriculture to the Agricultural Research Council. The staff now numbers about 150, including twenty scientific officers, thirty laboratory technicians, forty laboratory and animal attendants and thirty engineering and maintenance staff. The annual grant is at present about £200,000. Dr. J. B. Brooksby, who has been a member of the staff of the Institute since 1940, was appointed deputy director in January 1957.

Unfortunately, it was not possible to hold an official opening ceremony and to arrange for a large number of visitors to tour the laboratories on account of the disease security restrictions imposed on staff and visitors. As an alternative, a series of open days was held during June 18–20, to which representatives from several different spheres were invited.

On the first day, Lord Rothschild, chairman of the Agricultural Research Council, replied to a speech of welcome by Mr. Stephen Cheveley, chairman of the governing body. Lord Rothschild emphasized the high reputation of the Institute at home and overseas. He outlined some general principles which should be borne in mind in the fiercely competitive world of science and virology in particular. One of these related to specialization, which, like diversification, could be overdone. He stressed the importance of animal virology and suggested the desirability of pursuing work in this field with greater intensity and of giving thought to the possibility of diversification in the activities of the Pirbright Institute. In this connexion it is noteworthy that the terms of reference of the Institute allow it to undertake research on any viruses and the diseases they produce.

Demonstrations were arranged by the different departments and brief reference may be made to a selection of items of particular interest which were shown and discussed.

Extensive world epidemiological surveys have been carried out by the Institute since 1948, involving the systematic examination and immunological classification of samples of virus. In addition to samples from outbreaks of foot-and-mouth disease in Great Britain, others from Africa, Asia, Central and South America have been examined. There are now seven recognized main immunological types of the virus (compared with three in poliomyelitis, three in influenza, three in equine encephalomyelitis and two in vesicular stomatitis). The well-known *O*, *A* and *C* types (1922–26) have been found in Europe, South America, Asia and Africa. Work at Pirbright has brought to light three other types, designated *S.A.T.*1, *S.A.T.*2 and *S.A.T.*3, in Africa, and recently in 1955 a further type, *ASIA* 1, in five Asian countries. It has been found also that there are, as in influenza, within each of the main immunological type groups, strains of virus which differ sufficiently in antigenic constitution to classify them as variants or sub-types. All these findings are now realized to be of such international importance especially in relation to control measures, which in endemic areas would involve appropriate vaccination, that proposals for recognition of the Institute as the world reference centre for foot-and-mouth disease are under very urgent consideration.

Since the virus of foot-and-mouth disease exhibits a high degree of variability in this multiplicity of types and sub-types as well as in many other properties such as virulence for particular host species, spreading power and invasiveness, work has begun on the genetic analysis of the various factors affecting host–virus relationship. At the same time, studies are being made of methods of inducing variants in the laboratory. The methods employed, which include isolation of pure-line strains by the monolayer tissue culture 'plaque' technique and ultra-violet irradiation, were demonstrated. The necessity of making parallel genetic studies of variation in susceptibility of the host or host cell is appreciated, and already the results of the comparison of the susceptibility of two strains of mice to infection with the virus has demonstrated the influence of the host factor.

The Institute has been responsible for introducing many new methods and techniques which were demonstrated. All of these not only speed up diagnosis and type determination and the production and testing of vaccines, but also lead to greater accuracy in many tests, and economy in the use of the large and expensive experimental animals. They provide a wide range of opportunities for methodological selection and combination for specific objectives and for correlation of experimental data.

These techniques include four methods of virus titration. The first, reported in 1949, is multiple intradermal inoculation at different sites on the tongues of cattle of different dilutions of virus and determination of the 50 per cent end-point infecting dose. The second involves the inoculation intraperitoneally of different dilutions of virus into separate groups of unweaned mice. This followed

the demonstration at Pirbright in 1951 of the great susceptibility to infection of unweaned mice about a week old, in which a paralytic disease accompanied by heart and muscle degenerative lesions followed by rapid death was reported. The other two are tissue culture methods and were reported in 1954. In the first, different dilutions of virus are inoculated into small cultures of cattle tongue epithelium in rows of cups on a 'Perspex' plate. After incubation at 37° C., complement-fixation tests are carried out on the plate and the virus titre determined. Three years ago it was shown by the Institute that the virus of foot-and-mouth disease can be grown also in pig and ox kidney tissue cultures, and employing cell monolayers with an agar overlay in the Dulbecco 'plaque' technique the fourth method of virus titration was developed.

Attention was directed in the demonstration to the usefulness of unweaned mice in other directions: for the passage of field samples to secure suitable virus titres for complement-fixation and other tests, for serum neutralization tests to confirm immunological type, and to follow antibody levels as a supplementary test in assessing the potency of vaccines. It has been found possible also to infect by inoculation chicks and chickens (1954) and chick embryos with greater regularity than had been conceived possible some years ago. Attention was directed to the significance of these findings in opening up fresh lines of investigation and the development of modified or attenuated strains for immunization purposes.

In the biochemical department the results of work indicating the value of the gel-diffusion technique for identifying the virus types, the number of antigens in virus preparations and the antibodies in serum from convalescent animals were set out. It has been shown, with the seven immunological types of foot-and-mouth disease and the two immunological types of the virus of vesicular stomatitis, 'Indiana' and 'New Jersey', that the precipitin lines are disease- and type-specific.

The results of continued studies in the biophysical department on the analysis of the structure of the virus of foot-and-mouth disease and the complex response it stimulates in the host were demonstrated. Two components of the virus with different biological activity have been separated by centrifugal analysis, one about 20 mμ in size and the other about 8 mμ (1952). Electron microscopic studies have now made it possible to study the structure of the virus particles and treatments which lead to their disintegration.

Space will not allow of detailed reference to other demonstrations in the fields of pathology and experimental cytology; or to the application of tissue culture methods, on a scale suitable for vaccine production; or on a more fundamental level to detailed studies, on the growth and multiplication of the virus in different tissues in suspensions of cells, or in single layers of cells on a glass plate and on the relationship between the virus and infected cells.

Visitors were able to inspect the vaccine production unit which has been installed to enable the Institute to gain experience in large-scale work and so designed that modifications in the methods of vaccine production or indeed completely new methods may be introduced. In the past fifteen years at Pirbright much experience has been gained in testing vaccines for safety and protective power. Charts of these tests were shown and the techniques described. The visitors were also able to see one of the three new additional isolation units, each one entirely self-contained, for experiments on large animals, and ten units in a separate area for holding cattle for long-term immunity tests. They also saw the breeding unit for small laboratory animals, which functions on a mass-production system. A selective breeding system is maintained by detailed recording, and careful attention to hygiene and sanitation makes it possible to maintain the steady output of healthy stock required by the laboratories, which is of the order of 250,000 unweaned mice and 30,000 guinea pigs per annum.

The problem of controlling foot-and-mouth disease is one for international collaboration, and it seems that Britain is making every effort to make useful contributions in an attempt to diminish the world incidence of the disease and ultimately to eradicate it from many countries in which, unlike Britain, it is endemic. The work of the Pirbright Research Institute is of the highest importance, not only in relation to the problem of foot-and-mouth disease, but also in the better understanding and control of virus infections throughout the world.

SOLAR GRANULATION AND ITS OBSERVATION FROM A FREE BALLOON

By Dr. D. E. BLACKWELL and Dr. D. W. DEWHIRST
The Observatories, University of Cambridge
AND
Dr. A. DOLLFUS
Paris Observatory (Astrophysical Section, Meudon)

UNDER good observing conditions, the surface of the Sun, which usually shows a slightly mottled appearance, breaks down into a much finer network of minute bright spots on a very slightly darker background. The existence of these irregular spots, which are about 1 sec. of arc in diameter, corresponding to 750 km. on the photosphere, has been known for nearly a century. This structure is called granulation. Treated at first as a curiosity and a test of resolution in a solar telescope, the study of solar granulation is now beginning to be of great importance in solar physics.

Detailed models of the solar atmosphere show that the layers below optical depth $\tau \sim 1$ are convectively unstable[1], suggesting that granulation is itself a convection phenomenon. It has been supposed that the individual granules are Bénard cells arising from convection. Two other lines of evidence support the view that granulation is associated with convection. First, it has been shown by Richardson and Schwarz-

schild[2] at the Mount Wilson Observatory, by McMath and others[3] at the McMath–Hulbert Observatory, and by von Klüber[4] at Cambridge, that when the slit of a high-dispersion spectrograph is placed across a solar image, the Fraunhofer lines in the spectrum show spiky projections both on their red and on their violet sides. Such observations give directly the line-of-sight velocities in the photosphere; but it is important to notice that they cannot give the velocities associated with individual granules. Because of the relatively long exposure times necessary in high-dispersion spectroscopy and the rapid fluctuations in the quality of the solar image, it is seldom possible to obtain a resolution on the Sun of better than 3 sec. of arc. This means that we must be content to measure the average line-of-sight velocity of an area of the photosphere which is likely to contain several ascending and descending currents.

The second line of evidence, that depending upon a quantitative study of the Fraunhofer lines averaged over a relatively large region of the solar surface, is less direct, but equally convincing. It also shows that the region in which the weaker Fraunhofer lines are formed is turbulent. However, care is necessary in comparing the results of these two methods of investigation because they may not refer to the same scale of turbulence.

The importance of granulation does not end here. It has been suggested by Biermann[5] that a sunspot is due to the inhibition of the convective transport of ionized gases by a magnetic field, and hence a reduction in the outward flux of energy. Schwarzschild[6] has suggested that the corona is maintained by the flux of mechanical energy from the convection zone. But in spite of its theoretical importance, the subject is still in an elementary state. The sole reason for this lies in the difficulties of observation. Even at the best observing stations, atmospheric turbulence rarely permits a day-time image quality of better than 1 sec. of arc. In addition, it is not easy to approach the theoretical definition of even a 10-in. telescope when the optical components are subjected to the full flux of energy from the Sun. Moreover, the granulation is a low-contrast subject. For these reasons, little is known about the true structure of the granulation. In spite of more than half a century of work, virtually nothing is known about the variation of the structure of the granulation with wave-length, and only little about its variation with distance from the centre of the solar disk. It is apparent that the subject will not advance appreciably until better observations are made. The best that can be done from a ground station is exemplified in the beautiful work of Rösch[7] at the Pic du Midi using a refractor of 10-in. aperture. It is unlikely that photographs showing better definition can be made from the ground, even from a selected observing station. The reason for this is that much of the 'bad seeing' during day-time is caused by turbulence in the lower levels of the atmosphere arising from the heating of the ground by the Sun. An observatory on a mountain top is not necessarily free from this disturbance. The thickness of this turbulent layer undoubtedly varies from day to day and is dependent on local conditions; but if observations could be made from the air at a height of about 20,000 ft. above local land masses, the deleterious effects of the turbulent air will usually be avoided and a great improvement in the quality of the seeing may be expected.

Some experiments along these lines were made in 1955 by two of us (D. E. B. and D. W. D.), working in co-operation with the R.A.F. A fused quartz flat was mounted inside the open door of a Lincoln aircraft and used to reflect sunlight into an 8-in refractor fitted along the fuselage. However, disturbed air near the door of the aircraft even at a height of 22,000 ft. and mechanical vibration limited the definition to 5 sec. of arc. In assessing the difficulties of this work, it is helpful to bear in mind that photographing the Sun with the best resolution so far attained is equivalent to taking a legible photograph of the word 'NATURE' on the cover of this journal from a height of 2 miles. If worth-while progress is to be made, this limit must be decreased at least by a further factor of two.

To obtain the required definition, the ultimate aim must be to operate the telescope in quiescent air at such a height that it is above all the more grossly disturbed parts of the atmosphere, and the only practicable way to do this is to mount the telescope beneath a floating balloon. In 1956, work was begun at the Cambridge Observatories, in collaboration with the Paris Observatory, to investigate this possibility. One of us has already demonstrated the feasibility of making astronomical observations from a manned balloon[8]. A more detailed account of the apparatus used in a first flight and the results obtained with it has already been published elsewhere[9,10]. The telescope was of 11-in. aperture, and was guided manually on the Sun. Accurate guiding is very difficult, and the only reason why an experiment of this kind is practicable is that it is possible to take photographs with an extremely short exposure time. The exposure on the first flight was about 2 msec., but this was

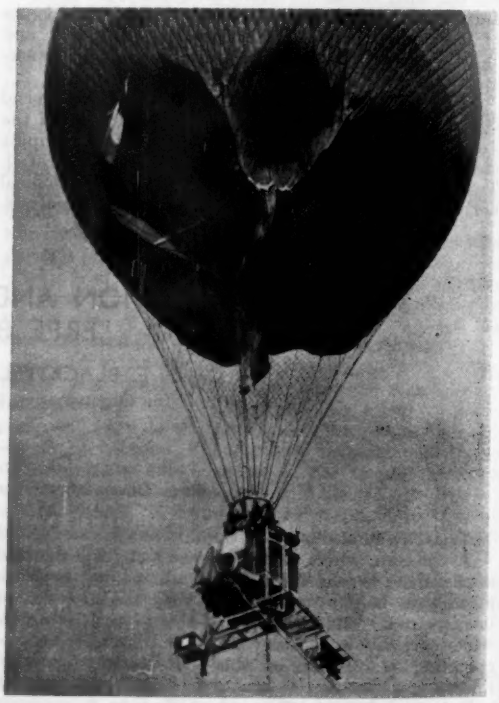


Fig. 1. Balloon and apparatus in flight

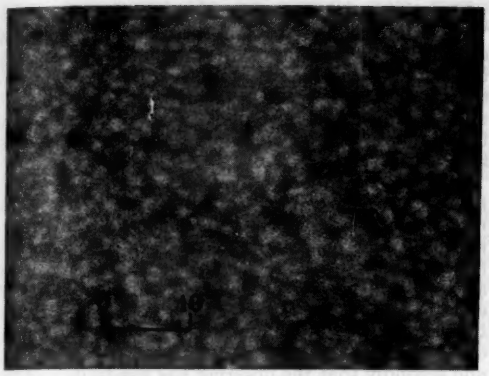


Fig. 2. A part of one photograph of the solar surface. Individual granules are mostly about 1·3 sec. of arc in diameter, but on the original negative smaller features can be distinguished

found to have been too long to counter the effect on the image quality of bad guiding, and the photographs show a sheared structure. For a second flight, therefore, this shutter was replaced by one operating at about 0·2 msec. This flight was made on April 1, 1957, from the Meudon Observatory outside Paris (observers A. D. and D. E. B.). A photograph of the apparatus and balloon in flight is shown in Fig. 1. A height of 18,000 ft. was attained and 480 photographs taken during a period of three hours.

Among other difficulties is that of predicting with sufficient accuracy the change of focus of a refracting telescope with altitude. The change may be as much as 2 mm. in a focal length of 3,000 mm., and as the focus is critical to 0·1 mm. it is necessary to take photographs over a range of focus settings. For this reason alone only one photograph in fourteen can show acceptable definition. However, the best photographs obtained are of excellent quality, and one photograph in particular appears to be at least the equal of any other that we have seen. A part of this photograph is reproduced in Fig. 2. Analysis of the photographs is still in progress, but it seems likely that the theoretical limit of resolution of the 11-in. objective has been reached. The ground-level seeing at the time of the flight was of poor quality, and the success of the photographs demonstrates that high-altitude observations of this kind are a feasible method of overcoming the previously insuperable difficulty of bad seeing. Plans for further flights with a larger telescope are now under discussion.

This investigation has been financed chiefly from a Royal Society Government Grant, with help from French special funds.

[1] Unsöld, A., "Physik der Sternatmosphären", 2nd edit. 215 (Berlin, 1955).
[2] Richardson, R. S., and Schwarzschild, M., *Astrophysical J.*, **111**, 351 (1950).
[3] McMath, R. R., Mohler, O. G., and Pearce, A. K., *Astrophysical J.*, **122**, 566 (1956).
[4] von Klüber, H., *The Observatory*, **76**, 68 (1956).
[5] Biermann, L., *Vierteljahrsschr. Astr. Gesellsch.*, **76**, 194 (1941).
[6] Schwarzschild, M., *Astrophysical J.*, **107**, 1 (1948).
[7] Rösch, J., *C. R. Acad. Sci., Paris*, **243**, 478 (1956).
[8] Dollfus, A., *C. R. Acad. Sci., Paris*, **239**, 954 (1954).
[9] Blackwell, D. E., Dewhirst, D. W., and Dollfus, A., *The Observatory*, **77**, 20 (1957).
[10] Blackwell, D. E., and Dewhirst, D. W., *J. Sci. Instr.*, **34**, 274 (1957).

AVOIDANCE OF COLLISION AT SEA AND IN THE AIR

A JOINT meeting of the Institute of Navigation, l'Institut Français de Navigation and the Ausschuss für Funkortung was held at the rooms of the Royal Geographical Society during June 5–7, on "The Avoidance of Collision by Airborne and Shipborne Means".

Collisions at Sea

Though the meeting was short it was most useful because it served to demonstrate the various points of agreement and controversy on a matter which is complex and subject to a good deal of public comment, not always informed. As the prevention of collisions at sea is an international matter, it is extremely valuable to discover the bases of common and contrary opinion by free and international discussion before the regulations come under review in the more inhibited atmosphere of a formal conference.

After a disquisition on the mathematics of collision avoidance, the meeting was invited to consider the causes of collision at sea, despite the use of radar, then the possibilities of avoidance by manœuvre and, finally, the contribution which electronic or other equipment may make, or be asked to make, to ease the task of the navigator in this regard. Fog or low visibility was assumed throughout.

On the first point there was no disagreement whatever. Speakers only differed in their manner of expressing the failure of the human element to understand the problem it was facing, or to make even reasonably good use of their equipment. It must be said at once that in most of the accidents described in which one of the ships was without radar, that ship usually had to carry a substantial and sometimes a major share of the blame.

The main failure in the radar-fitted ships seemed to be philosophical or psychological rather than technical, in the navigational or electronic senses; inability to understand that the danger mounts at an increasing rate as ships approach one another without reducing speed; failure to appreciate the importance of continuity of radar watching and of forming the habit of regular and precise observation. Some speakers mentioned lack of self-discipline and sense of responsibility and another suggested the necessity of breaking down the feeling of personal immunity from disaster, which is common to other walks of life.

The view was unanimous that better training was essential and that it should include instruction in the non-technical aspects just mentioned. There was no dispute concerning the need for seamanlike caution when interpreting the rule calling for moderate speed, or for progressive reduction of speed when approaching a close-quarter encounter. Of the twenty-eight ships involved in the collisions analysed by one speaker, twenty were found by courts or inquiries

to have been going too fast, and several maintained their speed up to the point of collision.

Controversy became apparent when consideration of manœuvring to avoid collision opened. The need for studying this subject arises from the agreed presumption that the present steering rules, that is, 'giving way' ship and 'standing on' ship, can only be applied between ships in sight of one another. In fog, therefore, there is a period, long or short, between radar contact and hearing or seeing the ship at close quarters, during which ships are under no obligation except to sound fog signals and go at a 'moderate' speed.

There are two main schools of thought on this subject, one which would strictly limit manœuvre to reduction of speed and to starboard alteration of course, and the other which would leave the choice to the seaman, presuming him to have been educated thoroughly in all aspects of technique and philosophy. The objection to restraint is that a rule to cover all situations will fail if it is too precise. Naturally this controversy remained unresolved and will no doubt be given much more thought.

On the subject of amending the collision regulations to take account of radar, diverse opinions were expressed. Some were in favour of special sound signals being provided to indicate that the ship was using radar. Others felt that this would lead to possibly dangerous assumptions as to both the intentions of the ship using it and the identity between the fog signal and some particular echo on the radar screen. All suggestions for amendment were left for further study, but the conclusions of the meeting expressed the need for attention to be paid to the interpretation, in the radar context, of the rules for moderate speed, altering course when at close quarters and stopping even before the fog signal is heard.

The subjects discussed under the heading of assistance from electronic or other equipment are best considered in two categories, depending upon the echo alone or on active co-operation from other ships; these categories also define opposing schools of thought.

On the whole, the former school found more support at the meeting than the latter, although one or two speakers did press the claims of the identification of ships whose echoes are seen, so that conversation or other means of exchanging intelligence may be established. The opposing case was that unless the complex and costly equipment needed was applied to all ships, whether radar-fitted or not, and was 100 per cent reliable, the navigator might be little better off. Further, if conversation and mutual agreement were to be the ultimate aim, it would involve severe language difficulties and radio congestion, both of which would give rise to delays intolerable in the circumstances. Further, the value of bi-lateral arrangements in multi-lateral and dynamic situations is, to say the least, doubtful.

There was no suggestion that electronics could not meet the requirement if it were to be posed, but there was no doubt that a system to provide precise radar identification for each of, say, 15,000 ships would be costly. If automatic coded transmission of course and speed information was needed the cost would rise, while if conversation were to be the aim, very high-frequency radiotelephone equipment would need to be provided universally.

The policy of depending upon the echo alone was shown to have two distinct channels, one dealing with echo movement and the other with echo shape. The object of both is to present the radar observer as rapidly as possible with intelligence concerning the course and speed of the ship whose echo is seen. With the ordinary marine radar of to-day, the orientation of the ship can be judged from the shape of her echo only in exceptional circumstances.

Systems which operate on echo movement vary, from the simple plotting by hand of measured radar ranges and bearings, to the recently launched 'true-motion' radar or the development of storage tubes (cathode ray tubes) on which the 'painted' path of an echo can be retained at will. Speakers extolled each of the modern devices and even combinations of them. Their advantages over manual plotting are first that the information-rate is much better, and secondly that the observer has less to do and less chance of making errors.

Dependence on the shape of the echo implies a very high degree of discrimination, and this is available in the greatest degree at the present time in the Q-band (8 mm.) radar, demonstrated by the Decca Radar Co., in England, and Messrs. Philips in Holland. It is still in a somewhat embryo state but, as the meeting was told, it does show the orientation of a 300-ft. ship at about 5 miles. An 8 mm. radar with a 12-ft. scanner will have a beamwidth of about 0·15°, providing 8 times better discrimination than a normal 3 cm. radar with a 6-ft. scanner. The speaker who favoured this system pointed out that such refinement in definition would make the heading of another ship evident from a glance at the echo, provided that it was within a certain range.

At longer ranges the heading will not be discernible from echo-shape, whereas with the echo-movement systems the effect of increased range is to decrease the information-rate. However, on balance the speaker was in favour of the echo-shape principle. He pointed out the susceptibility of the Q-band radar to interference from rain clutter; this and its shortcoming in maximum range make debatable its use as the only radar set in a ship.

The conclusions reached by the meeting showed that there was unanimity in assigning the blame for most of the collisions which have occurred to the human element, which often failed to appreciate the risks inherent in entering close-quarter situations at speed and to understand the limitations of and the best ways of using radar equipment. More and better training is needed in using radar and in the mental approach to encounters in fog, attention being devoted particularly to continuity of radar observation, and to reduction of speed and holding course when at close quarters.

The meeting hoped that technical advances would continue and be given impetus and direction by the studies of a working party which might be set up to consider the unsolved problems. F. J. Wylie

Collisions in the Air

At present collision avoidance in the air is based on visual avoidance manœuvres by pilots and, during poor flight visibility, on separation of aircraft under instructions of the air traffic control service on the ground. Separation by air traffic control is confined to the vicinity of airports and main air routes. The proposal to use airborne devices for collision avoidance is a comparatively recent one, and no such device has yet been produced. For these reasons, the

discussions during the air sessions were mainly exploratory, to determine the possible roles of such devices and possible principles of design. It was considered premature to make any recommendations at this stage, but the meeting was valuable in allowing a free exchange of views between those present, including specialists in many fields from the three countries and a guest speaker from the United States who has made a study of the physics of air collision avoidance.

The discussions were in three main parts. The first dealt with the statistics of air collisions and the mathematics of collision avoidance manœuvres. The second session considered air traffic control from the point of view of its limitations as a method of preventing collisions in all weather conditions and in all areas. The third session was devoted to possible airborne solutions.

The statistics of collision incidence were from the United States, because flying is practised on a sufficiently large scale in that country for the number of collisions occurring over a few years to have statistical significance. These statistics show that the overwhelming majority of collisions occur in good flight visibility; most are near airports and most are cases involving overtaking. From this evidence it is apparent that complete reliance cannot be placed on visual avoidance even in good visibility. Among reasons for this examined at the meeting were the extremely restricted field of view from aircraft cockpits due to fuselage streamlining; lack of aircraft conspicuity, especially against the Sun; physiological limitations of the human eye, such as the difficulty in focusing to infinity in the absence of a defined horizon or cloud; and psychological factors conditioning the quality and speed of the pilot's reaction to the collision hazard.

While much could be done to improve these conditions, it was agreed that such improvements could be no more than palliatives, especially taking into account the very high speeds of jet aircraft, which make visual collision avoidance virtually impossible.

The mathematics of collision avoidance in the air differs from that of the marine problem in several respects. The very much higher speeds of closing allow less time to make a decision, and if a turn is made it will probably need to be sustained until the other aircraft is passed. Apart from this, there is the possibility of using the third dimension. The effectiveness of an avoiding manœuvre can be expressed statistically, depending upon the probable accuracy of the parameters measured by the warning system. If the system is self-contained, that is, if it does not work in co-operation with a transmitter on the other aircraft, its effectiveness will depend on the accuracy of measurement of rate of change of relative bearing between the aircraft, or rate of change of speed of closing, both of which are zero in the collision case. It was pointed out that the accuracy with which these rates must be determined to distinguish the collision case is so high that it is only when aircraft are within comparatively short range that such rates can be distinguished from random perturbations of the aircraft in its flight. A warning time of thirty seconds seemed to be the practical maximum for such self-contained systems. These limitations do not, however, apply to co-operative systems, wherein a responding beacon in the other aircraft could continuously transmit its heading, speed and flight altitude if necessary, thus enabling the collision triangle to be solved continuously in the interrogating aircraft.

It seemed to be accepted by the meeting that air traffic control from the ground is necessary in areas of high traffic density, irrespective of any airborne device, to cope with the situation where several aircraft may present a mutual collision hazard and to maintain an orderly flow of traffic into and out of the airports. Separation of aircraft by control from the ground does, however, involve path restriction and delays, and is therefore generally confined to conditions of poor visibility, including night flying. A device which would assist pilots by warning them of the presence of other aircraft in good visibility might be a better solution than extending air traffic control separation to all weather conditions. The air traffic control service is further confined at present to the vicinity of aerodromes and to established air routes. The device mentioned could provide protection in other areas not so served.

On long-distance routes, for example, over the North Atlantic, where navigation and communication facilities are limited, very large separations between aircraft have to be imposed by air traffic control to allow a margin for navigation errors. This results in artificial congestion, including restriction of cruising altitudes, though the actual traffic density in physical terms is extremely low. There are two alternative approaches to this problem. The first is to depend entirely on better navigation and communication facilities and to lay down a system of alternative fixed routes to improve the control system. The second is to replace or supplement air traffic control from the ground by the use of airborne collision-warning devices. Operators are likely to continue to require freedom in choice of path on such long-distance routes, in order to take maximum advantage of the wind distribution in achieving minimum flight time and therefore operating economy. Such flexibility may be difficult to achieve with the complex route network necessary for separation of aircraft entirely by air traffic control. Opinions at the meeting differed on the extent of this difficulty. Using airborne collision-warning devices, there need be less restriction of flight paths, and it was generally accepted by the meeting that such devices in one form or another were desirable on such long-distance routes. They have the advantage of avoiding continuous restriction of aircraft flight path in order to cater for the very remote contingency of conflict with an aircraft on an adjacent path.

A number of different applications were suggested for collision-warning devices, and the type of device required may vary with these different roles. For example, a system for use in good visibility in areas of high traffic density would need to be limited in range to prevent too many spurious warnings. A system for use on long-distance routes where traffic density is much lower could be of longer range and so give the pilot sufficient time to assess the situation and perhaps, in co-operation with air traffic control, change altitude to avoid the other aeroplane. During the session on airborne solutions various possible principles of operation for collision-warning systems were examined, but no system has yet been proposed capable of giving a universal solution to the problem, that is, covering all possible danger sectors with every combination of aircraft speeds. Doubt was expressed at the meeting whether a self-contained system is feasible, but study is continuing because such a device would have the tremendous advantage of

giving immunity from all aircraft, and would not necessarily require universal adoption and standardization of design. Co-operative systems using equipment in both aircraft certainly seem more feasible, and various radio and radar techniques were discussed in relation to such devices. This is a field wide open for further study and invention.

Although no formal conclusions were drawn from this meeting, the discussions did show that there are several distinct possible roles for air collision-warning systems, and that their introduction may be inhibited by an attempt to fill all these roles with one infallible device. For example, a fairly simple system might be developed to provide proximity warning when overtaking another aircraft in visual conditions. This might warn the pilot of the presence and direction of the other aircraft, so that he could make an avoidance manœuvre visually. Such a device might have prevented the Grand Canyon disaster last year, and other similar accidents. It is possible that operational experience, gained by the use of comparatively simple devices of this kind, will indicate the lines for more advanced developments.

D. O. Fraser

NEWS and VIEWS

British Museum (Natural History) : Dr. H. W. Parker, C.B.E.

It has recently been announced that Dr. H. W. Parker, keeper of zoology in the British Museum (Natural History), is to retire on October 1. His tenure of the keepership has been outstanding for his introduction into museum practice of the principle that species are live populations in Nature, varying in time and in space, affected by ecological and geographical factors, and requiring statistical treatment of large samples and study in the field. No longer can it be said that a species is what resembles a particular specimen stuck on a pin in a museum. Dr. Parker's numerous publications reflect this infusion of the 'new systematics' into museum taxonomical work, and his monographs on the lizards of Somaliland, the Microhylid frogs and the Leptodactylid frogs are universally regarded as classical contributions to the subject.

Dr. F. C. Fraser

Dr. F. C. Fraser, who succeeds Dr. Parker, brings to the keepership of zoology a fundamental training in the principles of taxonomy and a long career of research into the life, structure and function of whales. In investigations undertaken under his supervision, the significance of the sounds emitted by whales under water has been elucidated by means of researches into the structure and function of the auditory apparatus, which show that whales are enabled to detect the direction from which the sounds come. This is a fundamental necessity for the continuance of the species by enabling the animals to meet in a medium where the senses of smell, sight, taste and touch are unavailing. In a recent communication in *Nature*, Dr. Fraser and one of his colleagues have put forward a new and objective explanation of the 'blow' of whales which seems likely to prove a major contribution to the solution of an age-old problem.

Mr. J. D. Macdonald

Mr. J. D. Macdonald is succeeding Dr. Fraser in the deputy keepership of zoology. Mr. Macdonald has been in charge of the Bird Room at the British Museum (Natural History) since 1944, and has been responsible for the new Bird Gallery and British Bird Pavilion which have met with great favour from visitors. He has travelled far afield in connexion with his researches, and went on ornithological expeditions to the Southern Sudan and to South-West Africa, whence he brought back valuable collections.

Geography at Bristol : Prof. W. W. Jervis

On the evening of June 14 a large company of past and present students of the Department of Geography in the University of Bristol bade farewell to Prof. W. W. Jervis, who retired from the chair of geography at the end of the academic year. Prof. Jervis, geographer and barrister-at-law, is a graduate of the University of Durham, having been a student at Armstrong College, Newcastle, before the First World War. His first appointment was as lecturer in mathematics and geography at Exeter in 1913. Shortly afterwards he was on active service, chiefly on the North West Frontier of India and in Mesopotamia. In 1919 he was appointed lecturer in geography in the University of Bristol and began to build up the now flourishing and active Department. Created reader in geography in 1926, he was elected to the first chair of geography in the University of Bristol in 1933. The events of the Second World War called a halt to further developments and the Department of Geography did not escape the damage inflicted upon Bristol and its University. During part of the War Prof. Jervis was again in uniform, commanding the 9th Gloucestershire Battalion of the Home Guard. On the return to peace-time conditions, Prof. Jervis and his colleagues faced the problems common to all universities against a background of re-creating a Department with its essential physical resources. There has been one very clearly marked feature of the work instanced in the Department's well-known and deserved reputation in surveying, reflecting Prof. Jervis's own interest in all matters appertaining to cartography. The spread of his graduates over many fields of employment and areas in the world is in itself a tribute to the achievements of the retiring professor.

Prof. R. F. E. W. Peel

Prof. W. W. Jervis is to be succeeded at the University of Bristol by Prof. R. F. E. W. Peel, of the University of Leeds, who graduated at Cambridge in 1934. His first university appointment was in the Department of Geography, King's College, Newcastle upon Tyne, in 1935. In 1938 he was granted leave of absence to join an expedition to Libya under the leadership of Bagnold, and his abilities as a geographer and anthropologist (he took the diploma in anthropology at Cambridge in 1935) were shown in both his contributions in the field and in published papers on his return. On the out-

break of hostilities in 1939 he was commissioned in the survey branch of the Royal Engineers, and he was among those evacuated from Dunkirk. Following a period of service in England he was posted to Italy and was in charge of the map production branch of the Survey Directorate. At the end of the War he returned to his post at King's College, Newcastle, but shortly afterwards was appointed to the staff of the Department of Geography at Cambridge. When the University of Leeds created an additional chair of geography, Prof. Peel was appointed to fill it and on the retirement of Prof. A. V. Williamson he became head of the Department. While at Leeds, in addition to obtaining and occupying new premises, Prof. Peel has visited East Africa and Canada, and sustained his interest in problems of the physical geography of northern England. His teaching and research interests are not, however, narrowly confined, and in the Bristol environment he will find satisfaction in the developments there in surveying and cartography, as well as in physical and human geography.

Second Geneva Conference on Peaceful Uses of Atomic Energy

THE second International Conference on the Peaceful Uses of Atomic Energy is to be held in Geneva during September 1–13, 1958. A provisional agenda has been agreed by the seven-nation Advisory Committee, of which Sir John Cockcroft is the member for the United Kingdom, providing for twelve plenary sessions embodying papers of a general survey type, and four parallel series of technical sessions covering the following subjects: Series 1: chemistry and the chemical processing of irradiated fuel, reactor technology, radiation damage in reactor materials, handling of highly irradiated materials, treatment of radioactive wastes; Series 2: nuclear physics including the physics of fission and fusion reactors, reactor theory, fuel cycles and the economics of nuclear power, research, test and prototype power reactors, reactor experiments; Series 3: production and uses of isotopes and ionizing radiations in research, medicine, agriculture and industry, dosimetry, biological effects of radiation, radiological protection, reactor safety and location, meteorological and oceanographical aspects of the large-scale use of atomic energy; Series 4: raw material supplies, winning and refining of uranium and thorium, methods of separation of isotopes, metallurgy and fabrication of fuel elements, processing of other nuclear materials.

The Conference will be conducted under the same rules of procedure as in 1955, which are published as Annex 2 in Vol. 16 of the Proceedings of the International Conference on the Peaceful Uses of Atomic Energy. Officials of the Conference, including the president, secretary-general and chairmen of the technical sessions, will be announced later. Arrangements for participation by the United Kingdom are being organized through an Executive Committee (chairman, Sir John Cockcroft; secretary, Mr. B. W. Mott) and a Papers Committee (chairman, Dr. B. F. J. Schonland; secretary, Dr. T. A. Hall) on which are representatives of the U.K. Atomic Energy Authority, the Central Electricity Authority, industry, universities and other bodies. Titles and 500-word abstracts of papers must be in the hands of the secretary-general of the United Nations by March 1, 1958, and final texts by June 1, 1958. At present the Papers Committee is engaged on the compilation of a provisional list of titles, with the object of estimating the number of papers likely to be submitted from the United Kingdom and their distribution between the various sessions. It is hoped that this information will be available by September 1, 1957. Organizations represented on the Papers Committee will be approached by their representatives for contributions, but others should communicate directly with the Papers Secretary, at the Atomic Energy Research Establishment, Harwell, Berkshire, if they have titles to submit or if they require further information. Inquiries concerning matters other than the submission of papers should be addressed to the Secretary of the Executive Committee, at the same address.

U.S. National Science Foundation Research Grant for Aslib

THE United States National Science Foundation has made an award of £10,000 to Aslib for research into the comparative efficiency of various indexing and literature search systems. The research programme, which is expected to take two years, is to be conducted at the College of Aeronautics, Cranfield, under the direction of Mr. C. W. Cleverdon, librarian of the College. Many new techniques have been evolved in recent years in an effort to overcome the problems created by the vastly greater flow of research papers and the increased need to locate information due to the growing complexity and volume of scientific and industrial research. The research which has been planned is intended to provide evidence as to whether and in what circumstances one indexing system is more efficient than another. First, some 20,000 research reports on aeronautical engineering matters will be indexed under five different systems. Strict controls, covering time and other relevant economic factors, will be maintained at all stages of the work. When this has been completed, it is intended to carry out exhaustive tests on the indexes in order to show their comparative efficiency in varying conditions.

Journal of Electronics and Control

STARTING in July with the first number of Vol. 3, the *Journal of Electronics* will contain an additional section dealing with control systems and mechanisms and its title will be changed to *Journal of Electronics and Control*. The Electronics Section will continue to publish papers devoted to all aspects of electron science as heretofore, and the new control section, which will be the responsibility of the recently appointed assistant editor, Mr. J. R. Day, will consist of contributions on any aspect of the science of control, either fundamental or arising in the context of industrial or other problems. The principles of detection and measurement, process control, the control of electrical and mechanical quantities in the field of servo-systems, the applications of electronic devices to control systems, and the automatic handling of data come within its purview, but not the study of organizational, economic and psychological factors involved in control engineering. Space will still be reserved in each number for book reviews, news items and correspondence. The number of pages will be increased from 100 to 130, and for the time being the frequency of publication of the *Journal* will remain unchanged—six parts per annual volume. There will be no increase in the annual subscription rate or in the price per single copy.

British Steel Castings Research Association

The British Steel Castings Research Association has entered into an arrangement with the Steel Founders' Society of America for the exchange of information at their respective annual conferences. Each Association will, in alternate years, invite the other to nominate a speaker to address its annual conference on a selected subject. The scheme is being initiated this year with an invitation to representatives of the British Steel Castings Research Association to address the Steel Founders Society of America Technical and Operating Conference, to be held in Cleveland, Ohio, during November 11–13, on the subject of the application of the graphite-rod resistor furnace to steel foundry practice, and the use in steel foundries of the immersion pyrometer for the measurement of liquid steel temperatures. This paper will be presented by Mr. T. A. Cosh, head of the British Steel Castings Research Association's steelmaking section, and Mr. L. W. Saunders, chief metallurgist, Lake and Elliot, Ltd.

British Iron and Steel Institute Translation Service

At the suggestion of the British Iron and Steel Research Association, the Iron and Steel Institute has agreed to organize a co-operative translation service. Plans are already well advanced, and a number of companies in the industry are collaborating with the Institute in setting up the service. The scheme will benefit the industry in two ways: not only will the range of available translations of foreign technical papers, including Russian publications, be considerably widened, but also much unnecessary duplication of effort will be avoided. Translations prepared by individual companies will be passed to the central 'pool', and these will be supplemented by translations from other sources. An index is currently being compiled of those translations made since 1950 which are still available, and lists of newly produced material and of translations in course of preparation will be published at regular intervals by the British Iron and Steel Research Association, the British Iron and Steel Federation and the Institute itself. Although primarily devised to serve the needs of the iron and steel industry, the new service will nevertheless be available to all who wish to take advantage of the facilities offered. An agreed scale of charges has been laid down which includes provision for substantial reductions where a number of copies of any individual paper are required. Inquiries should be addressed to the British Iron and Steel Research Association, 11 Park Lane, London, W.1.

International Group for the Study of the Fauna of the Soil

During the Sixth International Congress of Soil Science held in Paris in 1956, zoologists specializing in the study of the fauna of the soil formed an international group with the object of providing a means for the exchange of information among workers in this field. To achieve this aim, a *News Bulletin* is being published, and in addition international colloquia on particular aspects of the subject will be held at intervals. The first number of the *Bulletin*, which appeared in May, includes a questionnaire requesting details of current research projects together with information of animal groups studied. The results of this inquiry will be published in future numbers of the *Bulletin*, copies of which can be obtained from J. d'Aguilar, Station centrale de Zoologie agricole, Route de St.-Cyr, Versailles. The first colloquium, devoted to "Methods of Research in Soil Zoology", will be held at Rothamsted Experimental Station, Harpenden, Hertfordshire, during July 10–14, 1958, immediately prior to the International Zoological Congress to be held in London during July 16–23. The next issue of the *News Bulletin* will give the programme and other details of the colloquium.

Sugar Research in Mauritius

The annual report for 1956 of the Mauritius Sugar Industry Research Institute (pp. 92+xx. Réduit, 1957) includes papers on cane breeding, nutrition, soils, diseases and pests, weed control, cultivation and irrigation, effects of rainfall on production, and sugar manufacture. Both the total sugar production and the yield per unit area established new records. Only a few points from the research reports can be noted here. Breeding and selection studies have been continued along the usual lines for the crop. The induction of arrowing, that is, flowering, by photoperiodic treatments is to be attempted. Some interesting information has been obtained from mineral analyses of the juice of six cane varieties grown under different conditions of fertility and climate. For potassium, magnesium and calcium a strong varietal effect was found; for phosphate, however, the varietal effect appears to be weak with the varieties tested. The generally lower status of juices from high rainfall areas in all minerals has been noted. From the results obtained it would appear that the effect of increasing nitrogenous fertilization on the potassium and phosphate contents of juice is governed by whether or not an increase in yield occurs. With an increase in yield both potassium and phosphate decrease, but when no increase in yield is obtained the potassium and phosphate levels of the juice remain approximately constant irrespective of the amount of nitrogen applied to the crop. Foliar diagnosis has been used to advantage in determining the nutritional requirements of sugar cane in different areas. Indeed, the year 1956 marks the end of the first decade of organized control of fertilizer treatment, chiefly phosphate and potassium, based on this technique.

Auxin Inhibition in *Lunularia*

In the course of earlier investigations of the gemmæ of *Marchantia* and *Lunularia*, the possible existence of the phenomenon of apical dominance, as exemplified by the higher plants, was noted by C. D. LaRue and S. Narayanaswami. It is well known that the gemmæ of liverworts do not germinate within the gemma cup unless they are detached from the thallus, nor are adventitious buds formed on healthy thalli. These and related observations suggested a programme of investigations from which some interesting results have accrued (*New Phytol.*, 56, 61; 1957). Using *Lunularia*, it was found that excision of the upper halves of thalli above the gemma cups caused the gemmæ within the cups to germinate. Mutilations such as puncturing, slitting, excision of wings, etc., did not affect the gemmæ so long as the apical notches and the midrib regions were intact. This indicates the action of auxin inhibitors from the tips of thalli rather than the effect of a wound stimulus. The upper halves of thalli isolated by transverse cuts do not regenerate adventitious buds, whereas the basal halves do so from the cut ends. The regenerated

apical buds cause retardation of the growth of gemmæ in the same way as the original ones. Surgical experiments indicate the basipetal movement of inhibitors. Applications of growth hormones, such as indolylacetic acid, indolylbutyric acid and naphthaleneacetic acid in lanolin or in agar blocks, to the cut ends confirm the inhibiting influence of the apical notch and the latter as a centre of synthesis of inhibitors. Positive results for the formation of auxin have been obtained with *Avena* tests of the extracts of thallus tips. Preliminary experiments with analysis of such extracts by paper chromatography suggest that the auxin involved may be indole acetic acid.

Measurement of Body Radioactivity

THE papers given at a conference on the measurement of body radioactivity held at Leeds on April 16–17, 1956 (*Nature*, 178, 172; 1956), have recently been published (*Brit. J. Radiology*, Supp. No. 7. Pp. vi+130. London: British Institute of Radiology, 1957. 25*s*.). Measurements of body radioactivity were originally undertaken to measure the body burden of workers who had been exposed to radium and radon and of patients who had been injected with contrast-media containing thorium. Wider use will now undoubtedly be made of the techniques used in these investigations in determinations of the incorporation of fall-out in human populations. The radium content of the body of a chemist who died at the age of seventy-four after working for thirty-four years with radioactive materials was determined by workers in four independent laboratories. The reasonably good agreement of the results obtained by scintillation counting, ionization chambers and autoradiography gives confidence in the methods.

The admirer of big apparatus will enjoy the description of high-pressure ionization chambers containing 3,000 litres of gas at 20 atmospheres pressure, and of an instrument in which 108 photo-multipliers view the scintillations in 500 litres of liquid with a sensitivity of the γ-ray equivalents of 10^{-9} to 10^{-10} gm. radium in equilibrium with its daughter substances. The NaI–Tl crystal spectrometer developed by Marinelli and his collaborators shows the trend towards simpler instruments. The volume contains much information on many related topics like background radiation and the radium-content of drinking water in many parts of the world. It is very well produced, but summaries might have been added to the papers.

Algebraic Transformations to a Normal Population

AN interesting application of the use of an algebraic transformation of a variable to obtain a normal population is provided by a report, "Distribution conjointe de la température et de l'humidité de l'air au Congo Belge" (Publications de l'Institut National pour l'Étude Agronomique du Congo Belge, Bureau Climatologique. Communication No. 14. Pp. 31. Brussels, 1957), by Dr. F. Bultot. The problem related to the determination of the range within which 95 per cent of values of atmospheric vapour pressure occurred at specified temperatures in the Belgian Congo. Annual and monthly means of temperature and vapour pressure and even annual monthly means of the values for each hour were inadequate to give the limits needed. If the variables are normally distributed the range can readily be determined by drawing the ellipses of bivariate distribution. The actual temperatures and vapour pressures were found, calculating the coefficients of kurtosis and disymmetry, to have quite skew distributions. The values of the logarithms to base 10 of the temperature and of the cube of the vapour pressure, however, were found to be nearly normal. The standard deviations of these quantities, and the correlation coefficient between them, were calculated and the ellipses drawn. Figures for a number of places in the Congo are given, showing the ellipses corresponding to 95 and 99 per cent of the number of observations, with corresponding diagrams obtained by transforming back to direct values.

French Metallurgical Society

THE French Metallurgical Society is to hold its autumn meeting in Paris at l'Ecole Nationale Supérieure de Chimie, 11 rue Pierre-Curie, during October 7–12. At the meeting the following awards will be presented: the Grand Medal of the Society to Prof. G. Chaudron, for his services to metallurgy; and the Rist Prizes to G. Pomey and A. Gueussier. The programme of the meeting includes sessions on metal fatigue, rheology of metals, metallurgical problems posed by atomic power, the physics of metals and the physical chemistry of alloys. Further details can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9.

Manchester Literary and Philosophical Society

THE Manchester Literary and Philosophical Society recently elected the following officers for the year 1957–58: *President*, Dr. F. C. Toy; *Vice-Presidents*, Miss A. C. Alexander, Sir Geoffrey Jefferson, Prof. J. Kenner, Dr. Norman Smith; *Hon. Secretaries*, Dr. L. Cohen, F. Willett; *Hon. Treasurer*, H. Hayhurst; *Hon. Librarians*, L. L. Ardern, Dr. W. H. Brindley; *Hon. Curator*, N. G. C. Pearson.

Carlsberg–Wellcome Travelling Fellowships Awards

THE Carlsberg Foundation (Copenhagen) and the Wellcome Trustees (London) announce that the awards of Carlsberg–Wellcome Travelling Fellowships for the academic year 1957–58 (*Nature*, 179, 658; 1957) have now been made. Mr. Jørgen Berger, the Danish Fellow, a member of the teaching staff of the Department of Organic Chemistry, Denmark Pharmaceutical College, will study techniques of organic ultra-microanalysis with Dr. R. Belcher in the Chemistry Department at the University of Birmingham, and Dr. Stephen Paget Lapage, the British Fellow, who is a trainee member of the Public Health Laboratory Service, will work at the State Serum Institute, Copenhagen, on the biochemical and serological identification of enterobacteriaceae.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: C. E. Johnson (chief agricultural officer, Northern Rhodesia), assistant director of agriculture, Northern Rhodesia; J. V. Webdale (agricultural officer, Tanganyika), agricultural officer, Zanzibar; J. Blackburn (chemist, Tanganyika), assistant government chemist, Northern Region, Nigeria; A. F. A. Lamb (conservator of forests, Trinidad), chief conservator of forests, Sierra Leone; D. A. Harkin (geologist, Geological Survey Department, Tanganyika), deputy director of Geological Survey, Tanganyika; A. M.

Quennell (deputy director of Geological Survey, Tanganyika), director of Geological Survey, Tanganyika; D. H. Romney (scientific officer, British Honduras), senior scientific officer, British Honduras; R. H. Regnault (surveyor, Fiji), deputy director, Lands, Mines and Surveys, Fiji; A. L. C. Thorne (senior veterinary research officer, Federation of Nigeria), deputy director of veterinary research, Federation of Nigeria; J. Armstrong, agricultural officer, Northern Rhodesia; T. R. Barnes, agricultural officer, Western Region, Nigeria; W. J. R. Boyd, agricultural officer, Northern Rhodesia; A. J. M. Gunn, agricultural officer, Tanganyika; D. J. H. Jones, agricultural chemist, Northern Rhodesia; W. Keir, agricultural officer, Kenya; J. H. Simons, plant protection officer (plant pathologist), Western Region, Nigeria; C. R. Cratchley, geologist (geophysicist), Federation of Nigeria; J. B. Wright, geologist, Kenya; J. Ashton, senior surveyor, Northern Region, Nigeria; A. G. Bailey, scientific officer, Northern Region, Nigeria; C. M. Leslie, scientific officer, East African Industrial Research Organization, East Africa High Commission.

University News: London

The title of professor emeritus in the University of London has been conferred on the following: Prof. C. W. Dannatt, on his retirement from the chair of metallurgy at the Imperial College of Science and Technology; Prof. J. B. S. Haldane, on his resignation from the Weldon chair of biometry at University College; Prof. B. J. Lloyd-Evans, on his retirement from the Kennedy chair of mechanical engineering at University College; Prof. W. H. Pearsall, on his retirement from the Quain chair of botany at University College; Prof. William Wardlaw, on his retirement from the chair of physical chemistry at Birkbeck College.

The following appointments are announced: Dr. Douglas McKie, reader in the history and philosophy of science at University College, to the University chair of the history and philosophy of science tenable at that College; Dr. M. Freedman, lecturer in anthropology at the London School of Economics and Political Science, to the University readership in anthropology tenable at that School; Mr. S. J. Gould, lecturer in sociology at the London School of Economics and Political Science, to the University readership in social institutions tenable at that School; Dr. P. L. le Roux, senior lecturer at the London School of Hygiene and Tropical Medicine, to the University readership in medical parasitology tenable at that School; Dr. J. F. Sutcliffe, lecturer at King's College, to the University readership in botany tenable at that College.

Announcements

Mr. E. S. Hiscocks, secretary of the National Physical Laboratory, has been appointed director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office in Washington; he will also be attaché for scientific questions to the British Embassy. He will succeed Mr. H. J. Hadow, who has completed his term of office in Washington and will return to duty with the Department of Scientific and Industrial Research in England.

Mr. B. W. Collins, of the New Zealand Department of Scientific and Industrial Research Geological Survey Office, Christchurch, has been appointed scientific liaison officer in Great Britain, under Dr. V. Armstrong, at the New Zealand Scientific Liaison Office, which is a unit of the British Commonwealth of Nations Scientific Liaison Office, Africa House, Kingsway, London.

The British Scientific Instrument Research Association's laboratories at South Hill, Chislehurst, Kent, are to hold five open days during October 7–11. Inquiries should be sent to the Director at that address.

The Society for Water Treatment and Examination is to hold its autumn meeting at the Palace Hotel, Southend-on-Sea, during October 2–4. Further details can be obtained from the Hon. Secretary, 41 Carshalton Road, Sutton, Surrey.

The Institute of Personnel Management, jointly with the National Institute of Industrial Psychology, has arranged a five-day course in "The Use of Statistics in Personnel Management", to be held at the National Institute of Industrial Psychology, 14 Welbeck Street, London, W.1, during October 28–November 1. Further information can be obtained from the Training Officer, Institute of Personnel Management, Management House, London, E.C.4.

The Chemical Engineering Group and London Section of the Society of Chemical Industry are to hold a joint symposium on "Safety in Chemical Industry" on October 14 and 15 at the Royal Institution, Albemarle Street, London. Full details and application forms can be obtained from the Assistant Secretary, Society of Chemical Industry, 14 Belgrave Square, London, S.W.1; registration should be completed before October 5.

An informal symposium on "Column Packings for Gas Chromatography" will take place at the University of Cambridge on October 4. The meeting is being organized by the Gas Chromatography Discussion Group under the auspices of the Hydrocarbon Research Group of the Institute of Petroleum and will commence at 11 a.m. The proceedings will not be published in full. Application for tickets should be made before August 26 to Dr. H. Purnell, Department of Physical Chemistry, Free School Lane, Cambridge.

The first International Symposium on Gas Chromatography, sponsored by the Analysis Instrumentation Division of the Instrument Society of America, is to be held in the Kellogg Center for Continuing Education, Michigan State University, during August 28–30. The Symposium, under the general chairmanship of H. J. Noebels, is to be held in six sessions devoted to the theory of gas chromatography, the application of gas chromatography instrumentation in the laboratory, analysis of high-boiling materials by gas chromatography, the application of gas chromatographic techniques to the purification of chemicals, and gas chromatography instrumentation for continuous automatic analysis. All inquiries should be addressed to the Conference Registrar, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pennsylvania. Registration must be complete by August 15.

Erratum. Messrs. A. T. Willis and G. Hobbs state that in the communication entitled "A Modified Nagler Medium" in *Nature* of July 13, p. 92, the following correction should be made: par. 3, line 4, for "0·03 per cent neutral red", read ". . . 0·003 per cent neutral red".

BRITISH STEEL CASTINGS RESEARCH ASSOCIATION

NEW RESEARCH STATION

THE new Research Station of the British Steel Castings Research Association in Sheffield was opened on June 4 by Sir Harry Jephcott, chairman of the Council of Scientific and Industrial Research. The Station comprises an experimental foundry, laboratories and offices and is built on a site which is conveniently disposed in relation to the centre of the city and the main-line railway stations. The present buildings, which provide 12,500 sq. ft. of accommodation, occupy somewhat less than half a 2-acre site, leaving plenty of space for future expansion. The total cost of the buildings and equipment has been £93,000 and the Association is now provided with much-improved facilities for experimental work, which has previously been carried out in limited temporary accommodation and in the works of member firms.

The experimental foundry occupies an area of 90 ft. by 40 ft. and is large enough and sufficiently equipped to permit foundry processes to be investigated on a scale reasonably comparable with industrial practice. It is served by a 3-ton overhead-travel crane, operated electrically and controlled from the floor, and provision has been made for all essential foundry operations. Modern sand preparation plant is installed and, in addition to facilities for hand moulding and core making, there is a simultaneous jolt-squeeze moulding machine, a core blower and a shell moulding machine.

The main steel-making furnace is of 6-cwt. capacity and is a graphite resistor rod furnace, basic lined and operating at 225 kilowatts (single phase), a type of melting unit little known in Britain but popular on the Continent. This is suitable for pilot-plant scale steelmaking research. A smaller high-frequency furnace of the spark-gap type, with 30-lb. capacity, is also installed. The provisions for cleaning castings, welding and heat treatment are adequate for the largest size casting which can be made from the steelmaking furnace.

Grouped around the experimental foundry in two single-story bays are the machine shop and laboratories. The machine shop is fully equipped for pattern making and for the construction of special research equipment. The laboratories are devoted to metallurgy, mechanical testing, chemical analysis and the study of sands and refractories. The metallurgical laboratory houses two projection microscopes and two bench microscopes and also contains X-ray diffraction apparatus and a microphotometer. The latter equipment is being applied to a study of foundry dusts as well as to studies of sands and refractories and general metallurgical problems. Provision is also made for thermal analysis, and a dilatometer and equipment for the measurement of the hardenability of steels are under construction. The test house contains a 50-ton tensile testing machine and a combined Izod–Charpy impact machine with ancillaries for testing at sub-zero temperatures. Vickers and Brinell hardness machines and special equipment for the testing of miniature tensile specimens complete the equipment in this section.

The chemical laboratory is equipped for routine chemical analysis including semi-micro methods. Absorptiometric techniques of analysis are in use, and special equipment is provided for flame photometry and for the determination of hydrogen in steel. The sand and refractories laboratory houses equipment for the evaluation and control of foundry moulding materials, including a petrological microscope and a *p*H meter. Equipment for the differential thermal analysis of clays and the determination of refractoriness of sands, clays and refractories is under construction.

Offices for the research staff and space for storage are provided at one end of the foundry bay. A separate building contains a laboratory which is concerned with problems of industrial health. This work is primarily concerned with the assessment and control of airborne dust in foundries. The laboratory is provided with a dust tunnel in which known dust concentrations simulating foundry atmospheres can be generated and maintained for the calibration and comparison of dust sampling instruments. Provision has also been made for measurements of the efficiency of dust collecting equipment. Portable equipment is also available for a study of noise-levels and for analysis of the frequency distribution of noise.

A further single-story building houses the administrative offices and the library and information section, together with rooms for ciné photography and document copying. The Association makes considerable use of film for the dissemination of the results of its work, and the conference room, which can seat forty, is equipped for film projection.

The staff of the Association now totals forty-nine, of whom eleven are senior graduate investigators. In addition, four bursars are maintained at universities.

The occasion of the opening of the Station was marked by a special luncheon, which was attended by the Lord Mayor of Sheffield, the Master Cutler (Sir Peter Roberts, M.P.) and representatives of the University of Sheffield, the Department of Scientific and Industrial Research and member firms of the Association. In proposing the toast of the Association, Sir Harry Jephcott paid tribute to the design and layout of the Research Station. Mentioning the fact that 80 per cent of the industry were members of the Association, he urged the remaining 20 per cent also to join since, in his view, the work of the Association with its new facilities would undoubtedly make a material contribution to the technical efficiency of its members. He urged the Association to include in its programme an adequate proportion of fundamental research, which was always in the long run the best investment in research. He also stressed the importance of maintaining close contact with the universities and hoped that the Association, now that it had acquired its own laboratories, would not give up its practice of maintaining university bursars.

Replying to the toast, Mr. Kain, chairman of the Council of the Association, traced the origin of the Association, which had taken over the steel foundry work formerly carried on by the now extinct Steel Castings Division of the British Iron and Steel Research Association and the Research and Development Division of the British Steel Founders' Association, and paid tribute to those who had co-operated in its formation. He acknowledged also the assistance

which the Association received from the directors and staff of member firms on advisory and other committees. He stressed the need for qualified staff in the industry to apply the results of the Association's work and hoped that the Association would be able to play some part in providing facilities for education and training for nominees of members. Finally, he welcomed the representatives of the City and University of Sheffield.

After the official opening, the Association held a series of open days for the benefit of staff from member firms and others closely associated with the industry. In all, approximately 450 visitors have inspected the Research Station during the first and subsequent open days. A. H. Sully

BRITISH CAST IRON RESEARCH ASSOCIATION

OPEN DAYS

THE British Cast Iron Research Association, Alvechurch, Birmingham, held two open days on July 3 and 4, the first day being set aside for representatives of member firms, and the second day for visitors from other research associations, Government laboratories, trade associations, universities, technical colleges and institutions.

The new experimental melting station was opened by the president of the Association, Mr. J. J. Sheehan, on July 3. It covers an area of 5,000 sq. ft. and is fully equipped with oil-fired crucible furnaces, a 5-ton S. W. L. electric travelling crane, sand preparation and moulding equipment. In addition, it is furnished with four 'Efco' electric high-frequency melting furnaces of 10, 5, 2 and 1 cwt. capacity. Cupola furnaces, including facilities for both hot-blast and cold-blast melting, will be provided eventually, and will permit melting under both acid and basic conditions in a water-cooled melting zone. The annexe to the station is equipped for rough grinding, shot-blasting, heat-treatment, coremaking, and for carrying out small experimental melts. The equipment here includes a 30-kW. high-frequency vacuum melting furnace made by the National Research Corporation of Cambridge, Massachusetts, with a melting capacity of 30 lb.

Experimental investigations on view included the majority of the work in progress under the current research programme. Several investigations on the soundness of iron castings were illustrated and included the effect of physical variables and composition on the soundness of grey cast iron; solidification sequences in iron castings, and the soundness of nodular iron castings.

Aspects illustrative of the work on malleable cast iron included investigations on 'inverse' greyness in unannealed malleable castings, the influence of graphitization on decarburization, and a study of the nucleation of the melt by counting the eutectic cell size. Factors influencing the chilling tendency of cast iron and work on the solidification mechanism of white cast irons were also exhibited.

An effort is being made to provide data to enable cast iron to be used for steam engineering applications at temperatures above 450° F., the current temperature limit. Growth tests are being carried out up to 600° C. and the battery of creep testing machines recently installed will permit creep tests to be made on materials evaluated on the basis of these growth tests. Further work on mechanical properties refers to the correlation of composition and structure of high-phosphorus materials, based on the eutectic cell size concept. Other investigations under this heading include a scrutiny of the form of the stress/strain curve for grey cast irons; the influence of testing conditions and composition on the properties of pearlitic nodular cast irons; the influence of arsenic and phosphorus on the high-temperature tensile properties of these materials, and the influence of understressing on their properties in the normalized state.

A display was shown to illustrate the corrosion-resistance of ordinary and high-alloy cast irons in various media. Other work in this field covers the application of cathodic protection to prevent severe pitting attack in cast iron propellers, and the mechanism of the corrosion attack on cast iron diesel engine waterways in the presence of antifreeze solutions.

A recent project undertaken by the Association concerns an attempt to utilize low-phosphorus native ores by providing means of dephosphorization, and work shown included experiments with the oxygen top-blowing process. Equipment is available for the determination of gaseous elements in cast iron, using vacuum fusion and vacuum heating techniques. Certain of these elements are of significance in the study of pin-holing of iron castings, in the origination of enamelling defects, and in the graphitization of malleable cast iron. An investigation is in progress on the causes of the premature failure of ingot moulds, in association with the manufacturers of ingot moulds and bottom plates.

Current research on foundry moulding and core sands includes high-temperature testing, using a high-frequency oscillator to determine load/deformation characteristics at high temperatures; the testing and properties of CO_2 process sand moulds and the properties of bonded sand in the green state.

Routine methods of examination and analysis were demonstrated in the chemical and spectrographic laboratories, and in the sands, metallographic and mechanical testing laboratories. Work was also exhibited to illustrate some of the investigations undertaken by the Development Department which, of course, is chiefly concerned with giving advice to member firms on the numerous technical problems that arise in the course of production.

Experimental work on the occurrence of sub-surface blow-holes in association with manganese sulphide segregations was shown, and work on dry sliding and lubricated wear at high and low local pressures. A further exhibit gave the results of an investigation into the failure of certain heavy section castings due to abnormal forms of graphite, associated with the presence of traces of such elements as lead, tellurium, selenium and bismuth.

The work of the Foundry Atmospheres Section was illustrated by a display showing the pattern of formation, dispersal and control of dust in the foundry, together with dust sampling equipment. Some of the equipment developed for local dust control was also shown and included external dust control arrangements for pedestal grinders, a wet spray collar for bars used in de-coring difficult castings, a ventilated wire handbrush and wet spray type of grit and dust arrester for cupola furnaces.

Finally, some of the work based on the experience of the operational research team, which visits foundries by invitation and provides advice on problems of production and layout, was shown, and included recommended suitable foundry layouts, improvements in production flow lines, the correct use of patterns and moulding equipment, and data on output and costs.

J. G. PEARCE

ORGANIZATION OF THE METEOROLOGICAL OFFICE

IN a written answer in the House of Commons on June 28, the Secretary of State for Air, Mr. G. Ward, said that the Committee appointed in 1955 under Lord Brabazon to review the organization of the Meteorological Office in relation to current and future requirements saw no reason to question the wisdom of the decision to entrust responsibility for the State meteorological service to the Air Ministry, and was satisfied that the close association of the Meteorological Office with aviation since 1919 had been mutually advantageous. The Committee considered that the present standing of the Meteorological Office as a scientific institution was high, and that users had great confidence in the services provided. The Committee welcomed the work being done by the research staff in the development of numerical methods of forecasting, and the decision to install an electronic computer at the Central Forecasting Office. It considered that greater precision in local forecasting might be achieved by more detailed study of local weather characteristics, coupled with the use of radar scanners. The development of a combined headquarters at Bracknell should eliminate the present loss of effort due to dispersal of the Office.

As a result of the Committee's recommendations, the Meteorological Office had been reorganized under a director-general with two sections, concerned with forecasting and services and with research, each under a chief scientific officer, and a third section, under an assistant secretary, with administration and general duties. Measures approved as a result of the report, including an increased number of higher level posts, and an increase in the number of senior appointments open to the experimental officer class, would improve the prospects available to both the experimental and the scientific officer classes. The Committee expressed the hope that it would be possible to bring home to the universities the challenge which meteorology presented to the imagination of the first-class physicist or mathematician.

The Committee suggested no changes in the constitution or terms of reference of the Meteorological Research Committee or in the division of the research programme between the Meteorological Office and the universities, but recommended that the arrangement under which a separate grant is made to the Royal Society for fundamental research should be reviewed at the end of the current five-year period and that grants for research emanating from the Air Ministry should thereafter normally be channelled through the Meteorological Research Committee. This recommendation was still under discussion. The Committee also recommended a system of research grants for postgraduate study in meteorology, and the Department of Scientific and Industrial Research was willing to consider awards under the scheme it administers.

The Committee also recommended a review of the man-power requirements for aviation services. The requirements of civil aviation were being reviewed in conjunction with the Ministry of Transport and Civil Aviation. Local forecasting units were desirable for other purposes, particularly in agricultural and horticultural districts, but a more detailed examination was required before any pattern of development could be approved. The Minister said that he had accepted the Committee's recommendation that the existing Meteorological Committee should be replaced by an advisory committee of not more than five members, all of whom would be outside the Government service. The new Committee would consist of an independent chairman, and four members, including the chairman of the Meteorological Research Committee *ex-officio* and another scientist, appointed after consultation with the president of the Royal Society, and normally two laymen. Lord Hurcombe had accepted the invitation to become chairman of the new Committee, which would be required to keep under review the progress and efficiency of the Meteorological Office and the broad lines of its current and future policy, the general scale of effort and expenditure devoted to the Meteorological Office, and the contacts between the Office and those using its services.

WATER RESOURCES OF GREAT BRITAIN

THE publication of the Surface Water Year Book 1954–55* is a further welcome addition to the growing body of hydrological knowledge for Great Britain. The first four Surface Water volumes dealt with the periods 1935–36, 1936–37, 1937–45 and 1945–53: since that date the volume has been appearing annually and the time-lag in publication has been steadily reduced.

There has been an increase from 102 gauging stations in 1953–54 to 116 gauging stations in this latest volume; but some changes have been made in the presentation of the statistics for 1954–55 in order to reduce both the size and the cost of the volume. The daily mean discharge tables have been omitted, while hydrometric records of 'reservoired areas' have been summarized on a single page. The station descriptions have been rearranged and condensed, and the surface geology particulars omitted. Complete records and details are, however, available for consultation at the Surface Water Survey Centre.

While progress is thus being made in the collection and dissemination of these basic hydrological data concern is still being expressed at the lack of a much-needed water policy for Great Britain. A notable debate in the House of Lords on May 29 surveyed the steadily increasing consumption of water per day, and also the rising consumption of water per head per day throughout the country. Emphasis was laid upon the very great and continuing increase in the industrial use of water over the past two decades, to which must be added the demand likely to arise in agriculture with the application of summer irrigation methods. Some areas now face the prospect of permanent water shortages even under normal

* Ministry of Housing and Local Government, and Scottish Office. The Surface Water Year-Book of Great Britain 1954–55. (Hydrometric statistics for British Rivers, together with related rainfalls, for the year ended 30th September, 1955.) Pp. xl+54. (London: H.M.S.O., 1957.) 15*s.* net.

conditions, while a slight drought will rapidly exhaust available reserves and bring industry and agriculture to a standstill in other localities.

Replying for the Government, Lord Mancroft stated that the subcommittees appointed by the Central Advisory Water Committee of the Ministry of Housing and Local Government in 1955 would be pressed to complete their investigations as a matter of urgency. The Government hoped for a reduction in the large number of water undertakings in the country (nearly 1,300) by voluntary amalgamations. It was also studying the whole question of the organization of hydrological research, as one of the chief difficulties in the present situation was the lack of reliable information. No authoritative figures of the rate of increase of water consumption, nor of the available total resources, existed. It was fully realized that not enough information was yet available to assess accurately exactly how serious the problem was likely to be, but "Her Majesty's Government are most earnestly and objectively going into this whole problem" as the urgent need for a more precise assessment of the situation had been recognized.

W. G. V. Balchin

THE WELLCOME TRUST

REPORT FOR 1937–56

THE first report of the Wellcome Trust, recently issued*, covers the first twenty years of the Trust's activities, during 1937–56. Its major interest is in the general survey of the origin and activities of the Trust, which occupies the greater part of the report, including an appreciation of the work of the founder, the late Sir Henry S. Wellcome. There are a classified list of grants and a clear statement of the policy pursued by the trustees, with appended lists of recipients of various medals and prizes awarded by or on behalf of the Trust, and of publications from the Wellcome Trust Research Laboratories or subsidized by the Trust. During the period the trustees have made grants totalling £313,883 for medical research, museums and libraries, and have allocated £64,053 to assist research in the history of medicine. £48,335 has been spent on completing Sir Henry Wellcome's "Archæological Enterprises", and on publishing the findings of these and a related independent study, while £4,105 has been provided for Wellcome medals and prizes. To August 31, 1956, a total of £739,788 had been provided for medical and veterinary research, of which £300,000 was allocated in respect of building and other projects not yet effective. Of this sum, £193,090 was for research chairs, £321,700 for building, adaptation and equipment of research laboratories, £52,215 for special equipment, and £7,699 for miscellaneous travel grants.

For reasons given in the report the trustees had to postpone for more than ten years the full development of the main activities of the Trust, and in the meantime they recognized that the archæological enterprises which Sir Henry Wellcome had been supporting at Jebel Moya and other sites in the Sudan, and at Tell ed-Duweir (Lachish) in Palestine, had prior claim. The results of the former work at Jebel Moya were published for the trustees by the Oxford University Press in 1949, and those of the explorations at the neighbouring sites of Abu Geili, Segadi and Dar el Mek in a later volume, while after excavation at Lachish was terminated by the outbreak of war in 1939, the results were prepared for publication by Miss O. Tufnell.

At an early stage, however, the trustees considered the choice of areas of research in medicine and related sciences in which they could plan to use the funds at their disposal to serve the objects of the Trust: the advancement of research bearing on medicine, surgery, pharmacy and allied subjects, and the establishment, endowment and maintenance of research museums or libraries in that field. They took the view that these funds would be used to the best advantage if not too widely diffused, and if their activities were planned so as to be complementary to those of other funds with similar aims. Accordingly, they decided to give preference to those subjects which had attracted Sir Henry Wellcome's own active interest and so to give priority to work in pharmacy and pharmacology, veterinary medicine and tropical medicine. While continuing to provide funds for the several medals and prizes established by Sir Henry himself, it is not a part of the trustees' present policy to consider the creation of other such awards.

In 1938, the trustees accepted full responsibility for the laboratory at Thessaloniki, where Dr. H. Foy had been engaged on research in malaria, and the laboratory was named the Wellcome Trust Research Laboratory, Thessaloniki. In 1953, the appointment of Dr. Foy was given academic permanence. Later, the laboratory was extended, and when continuation of the work at Thessaloniki became impossible at the end of 1940, the work was transferred to the South African Institute of Medical Research, Johannesburg, until work could be resumed at Thessaloniki in 1945–48. With the reduction of the prevalence of malaria to very small proportions in consequence of the insecticides discovered during the War, it was again decided to close the Thessaloniki laboratory, and since 1949 Dr. Foy and his co-workers have been working, with Nairobi as base, on a programme now including the study of nutritional and other forms of anæmia widely prevalent in the tropics, as well as the distribution of the sickle-cell trait. In 1942, the trustees made a grant of £20,000 for further research on the development of methods for drying human blood-plasma and serum and for the purchase of the necessary plant, and between February 1943, when the plant came into operation, and September 1945, when it closed down, this plant provided stable dried plasma and serum to meet the whole of the requirements of the Royal Navy and of the civilian population of Britain, and a proportion of those of the Army and of the Royal Air Force.

A grant of £44,000 was made in 1945 for the creation of the Wellcome professorship of clinical tropical medicine in the London School of Hygiene and Tropical Medicine, and one of £74,000 in 1946 for the endowment of a full-time Wellcome professorship of pharmacology in the School of Pharmacy, University of London. Grants of £18,000 were made to the Animal Health Trust and of upwards of £10,000 to the Pharmaceutical Society for research fellowships, and £15,000 was awarded for various research fellowships in such subjects as biochemistry—while in 1956 a Wellcome research professorship of anæsthesiology was established at McGill University with a total grant of about £50,000; together with a Wellcome associate research professorship at the University of Pennsylvania, with a grant of about £25,000.

* The Wellcome Trust. First Report covering the period 1937–1956. Pp. 86. (London: The Wellcome Trust, 1957.)

SURFACE ACTIVITY

THE Second International Congress of Surface Activity was held in the Senate House of the University of London during April 8–13. The enthusiasm shown by participants emphasized that the popularity of this subject in both the scientific and industrial interests throughout the world had in no way diminished since the First International Congress, held in Paris in 1954. Since the United Kingdom had the largest foreign contingent to the First International Congress, the International Union of Pure and Applied Chemistry asked the United Kingdom to undertake to arrange a second congress.

The late Dr. L. H. Lampitt, the British representative on the International Union of Pure and Applied Chemistry, and also the vice-president and honorary treasurer, gathered together a meeting of British scientists, both academic and industrial, who might be interested in the subject. This meeting elected an *ad hoc* committee under the chairmanship of Dr. Lampitt to proceed with the organization of a congress along the lines of the First International Congress in Paris. This committee decided that the subject-matter of the Second International Congress should be extended to include other aspects of surface activity than those discussed at the first world meeting, which was mainly on detergency. The Comité Français de la Détergence sponsored and organized the First International Congress. It arranged the first programme on industrial lines, in so far as the subject-matter was chosen from the industrial applications of surface chemistry rather than from the basic science. Moreover, the subjects were subdivided into seventeen divisions, which were run concurrently, necessitating a serious overlap of interests.

This the *ad hoc* committee for the Second International Congress now decided to change. The organizing committee accepted a programme drawn up with a scientific bias, with contributors both from academic and industrial research laboratories throughout the world. The contributors were asked to place their work under sections derived from surface activity taking place at specific interfaces, such as gas–liquid interface, liquid–liquid interface, solid–liquid interface, solid–gas interface and cell–water interface. Furthermore, to avoid overlap of interests, the sessions were to be run concurrently in only two lecture theatres, and the programme was so chosen that, so far as possible, sessions on allied subjects would not clash.

It was originally hoped to have approximately one hundred contributions, which it was thought possible to discuss in two lecture theatres over four days; but such was the world enthusiasm for this subject that more than two hundred contributions had already been received by the closing date, and late contributions were more than sufficient to start a Third International Congress. It was considered, after much hesitancy, that the two hundred papers should be accepted and that they should be run approximately twenty-five a day for the four days, in each of the two lecture theatres. It was decided that contributions should be pre-published and pre-circulated throughout the world to participants, so that the papers could be taken as read at the Congress meeting. It was considered that by this method two hundred papers could be fully discussed.

It was estimated that approximately one thousand people would attend such a meeting, which restricted the choice of venue to the Senate House of the University of London, where two large lecture theatres, the William Beveridge Hall and the Institute of Education, each seating more than five hundred, are available. It turned out that approximately one thousand people paid to come to the Congress, and since both lecture theatres were consistently full (sometimes over-full) throughout each of the four days of the meeting, it would appear that many more attended.

The contributions were sent in from nineteen countries, and were fairly evenly distributed throughout the world. Apart from the United Kingdom, which contributed eighty-three papers, they included the following countries, with the number of papers in brackets:

United States (32)	Australia (7)	Poland (2)
U.S.S.R. (21)	Belgium (6)	India (1)
France (9)	Canada (5)	Kenya (1)
Germany (8)	Italy (3)	Sweden (1)
Holland (8)	Finland (2)	Switzerland (1)
Japan (8)	Israel (2)	Yugoslavia (1)

The programme was arranged in the two lecture theatres *A* and *B* in the following sections:

A		*B*	
First day			
Gas/Liquid and Liquid/Liquid Interface (32)		Solid/Gas Interface (39)	
Insoluble films	14	Physical adsorption	26
Soluble films	7	Chemisorption	13
Foams	4		
Evaporation retardation	3		
Monolayers liquid/liquid interface	4		
Second day			
Gas/Liquid and Liquid/Liquid Interface (24)		Solid/Gas Interface	
Solubilization and micelles	13	Chemisorption (continued)	
Emulsions	7		
General phenomena	4	Electrical phenomena (15)	
Third day			
Solid/Liquid Interface (22)		Solid/Liquid Interface (28)	
Washing	14		
Suspensions and agglomerations	8	Contact angles, spreading and wetting	10
		Flotation	18
Fourth day			
Cell/Water Interface (Biological) (13)		Solid/Liquid Interface (25)	
		Flotation (continued)	
		Adhesion	6
		Adsorption	9
		Lubrication	5
		Nucleation	5
Total 91		Total 107	

The long-suffering publishers of the proceedings of the Congress have arranged to print the discussion in four volumes: Vol. 1 to include gas/liquid and liquid/liquid interfaces; Vol. 2 to include washing, suspensions and agglomerations and cell/water interface; Vol. 3 to include solid/gas interface, physical adsorption and chemisorption; and Vol. 4 for solid/liquid interface, including electrical phenomena. It was considered that dividing the interests in four volumes, offering reasonable economic units for those interested in selected topics, was preferable to publishing the whole proceedings of the meeting in a more expensive single unit. The written discussion of the transactions at the meeting has been found to be unexpectedly voluminous, but the proceedings of the Congress should appear in the near future, while world interest is focused on modern surface activity.

The entire proceedings should give a very useful up-to-date version of modern surface chemistry in all its aspects, both pure and applied, and will take several years to digest.

The discussion at the Congress seemed to specialize in classical surface chemistry at the air/liquid and liquid/liquid interfaces, such as thermodynamics of adsorption at interfaces and micelles, evaporation retardation, transport of material across liquid/liquid interfaces, formation of emulsions, the meaning of contact angles at the solid/gas/liquid line interface, long-range forces at solid surfaces and nucleation phenomena. It was truly astonishing to listen to the thermodynamic specialists expressing opposing views, with complete confidence that the opposing side was wrong and that they were fundamentally correct. It was somewhat horrifying to notice that the thermodynamic concepts and terms were frequently misused. For example, Harkins free energy term was repeatedly misquoted as a Gibbs free energy term, and systems used by Hill, Guggenheim, Harkins and Everett freely intermixed. It seems essential that some common system with defined symbols should be established once and for all.

There was relatively little discussion on the solid/gas interface, presumably since there were very high-geared participants in the audience which possibly frightened off discussion, and unfortunately the chairmen were conscientious and ruthless about being on time with their programme. But there were some very interesting papers in this section, especially those dealing with perturbation effects of the adsorbing molecules on solid surfaces, and also of the solid surface on the adsorbing gas molecules. This was shown experimentally by infra-red adsorption of the molecules in the adsorbed phase. This work has immediate application to studies in catalysis and possible means of measuring changes in bulk properties of solids by changes in surface phenomena. There were some interesting papers, partly in review, on the surface energies of solids in relation to their chemistry, which has interesting possibilities for future work in this intriguing field.

Some workers in the solid/liquid interfacial field related all the occurring phenomena to the inherent roughness of the solid surfaces. Others seemed to have such smooth surfaces that they could measure attractive forces between solid surfaces at molecular distances apart. Each party was completely unconvinced by the arguments of the opposing side.

One of the applied subjects which aroused interest was the use of long-chain hydrocarbon alcohols in the form of condensed monolayers in retarding the evaporation of water. On the laboratory scale this is successful up to 90 per cent; on field trials on areas of about an acre the efficiency is about 30–40 per cent, using alcohols spread from floats containing solid beads of the material. Hope was given that by using liquid spreaders in which the long-chain alcohol is soluble, the film could be spread and held on areas of square miles. Since water evaporates in Australia at the rate of about six million tons a year per square mile, the economic stimulus to this type of work is most pronounced. Papers dealing with the role of water molecules selectively adsorbing at crystal surfaces, either soluble in saturated water solutions or insoluble in the form of powders in the atmosphere, have very interesting practical implications: in the first case for the selective flotation of soluble salts, and in the second case for nucleation in cloud seeding experiments, where copper sulphide is shown to be the best seeding agent, and zinc sulphide, for example, one of the worst.

The meeting presented a great opportunity for scientists of the Western world to listen to and to learn the methods of the Russian and Polish scientists, expressed mainly in English. This was invaluable, since the Russians are more active in the field of surface chemistry than their Western colleagues, and their papers with references present a good record of their recent research.

From the enthusiasm shown by those producing original manuscripts and by participants at the discussion, there should be no difficulty for the organizers of the next International Congress to start thinking soon on a programme for the third world meeting.

J. H. Schulman

STUDIES ON FERTILITY

The seventh annual conference of the Society for the Study of Fertility was held in Exeter on July 5 and 6. As in the past, papers were read on clinical, basic scientific and veterinary subjects covering the field of fertility in its broadest sense.

From the Liverpool School, already well known for its contributions to testicular and male accessory-organ anatomy and physiology, came two further papers. E. J. Clegg studied changes in the coagulating glands and seminal vesicles in rats by killing litter mates at weekly intervals. He found the former to be histologically more labile than the latter and, since there was no simple relation between age, testicular histology and the fructose content of the coagulating gland, concluded that fructose content was not a reliable indicator of hormone production. In discussion, it was pointed out by T. Mann that the fructose content of the secretions, rather than of the gland cells, was likely to be of more significance, while J. Macleod drew a parallel with Leydig cell secretion rather than numbers as of importance from the point of view of testis hormone production. E. W. Macmillan, also from Liverpool, has continued his studies on sperm transport through the epididymis of the rat. Since ipsilateral orchidectomy after the introduction of radio-opaque medium into the vasa efferentia does not affect the time of passage through the vas deferens, it is concluded that the *vis a tergo* from the testis is of no importance. The rate was similarly unaffected by ligation of the terminal efferential tubule or by high ligation of the ductus epididymidis. Trypan blue particles are transported in the same way as radio-opaque media.

A symposium on the methods of testing for spermicidal activity was opened by T. Mann (Cambridge), who pointed out that no single biochemical mechanism was affected by all spermicides, and that there were at least three groups of these: enzyme and competitive inhibitors, sulphydryl-binding substances, and surface-active agents. Clare Harvey (Exeter) discussed the dichotomy of opinion on whether the end-point for tests should be the concentration required to kill within a fixed time, or the time required to kill at a fixed concentration. She preferred the former (modified Baker test of total spermicidal activity). B. Carruthers (London) said that at the Family Planning Association Laboratories, satisfactory results had been obtained with the modified Baker test. He also mentioned his studies with the Davidson contact test and how the results could be affected by various factors, especially

ingredients in the vehicle themselves not regarded as spermicides. P. E. Lindahl (Sweden) described how he has replaced the upper and lower glass surfaces of the cell used in the Davidson test by semi-permeable membranes, permitting the access of oxygen, since he believes conditions within the vagina to be aerobic, not anaerobic. J. Macleod (New York) said that a special laboratory has been set up at the Sanger Bureau of the International Planned Parenthood Federation, with the express purpose of investigating all the existing methods of spermicidal testing. He himself believed that fundamental studies on spermigration are urgently needed.

There were two papers on the effects on pregnancy of certain antimetabolites and nucleotoxic compounds. J. M. Robson and D. Jackson (London) considered three groups of substances—spindle poisons, such as podophyllotoxin, colchicine and demecolcine; mitotic poisons, such as chlorambucil and nitrogen mustards; and antimetabolites, such as 6-mercaptopurine and furazolidone. Most of these were effective in interrupting pregnancy, some even before the stage of implantation; but, in general, the therapeutic ratio was too low for them to have any practical value. Of those agents which were effective before implantation, the antimetabolites seemed most promising. J. Yudkin, B. P. Wiesner and Miriam Wolfe had found β-peltatin less active, but with a higher therapeutic ratio than podophyllotoxin. α-Peltatin was more active and less toxic than β-peltatin. Two doses, given on successive days, were more effective than a single dose. Demecolcine was very effective, but the escaped litters after marginal doses showed many congenital abnormalities and the surviving offspring had impaired fertility. It was promising for future research that slight changes in chemical structure markedly influenced both effectiveness and toxicity.

M. G. Scott and Patricia P. Scott (London) have made detailed studies of the effects on the reproductive organs of cats of chronic infections, dietary inadequacies and ligation of the pancreatic duct. These all led to retardation of development and regression of the gonads and accessories. In the testes abnormal cell types were seen, while poor follicular activity was found in the ovaries. It was concluded that the primary effect in all cases was malnutrition rather than a direct influence of the chronic infection, and that it was exerted on the anterior pituitary body, the gonadal changes being secondary.

Hilda M. Bruce (London) said that all the hamsters at present in the western hemisphere were descendants of a single litter found at Aleppo twenty-five years ago. About twelve varieties were now recognized. Of these, the ruby-eyed fawn mutant showed genetic sterility in the male. Her investigations on this revealed that fertility is confined to a period of 2–3 weeks after puberty, the subsequent progressive infertility being due to increasing defect of spermatogenesis. The testicular histology showed disorganization of isolated tubules even in young and still fertile animals; this process progressed with advancing age so that by 150 days sterility was complete. Multinucleate cells (similar to those found by Scott and Scott in their subnormal cats) appeared. In the ensuing discussion, T. Mann pointed out that copper-containing enzymes are implicated in both pigment formation and spermatogenesis, suggesting a possible enzyme defect as the basis for the genetic sterility.

Delphine M. V. Parrott (London) described a technique for orthotopic ovarian grafting which avoided the difficulties of surgical removal of the ovaries in the recipient mouse, by subjecting the animals to 900 r. of whole-body irradiation, followed by the injection of bone marrow from other mice. A later modification was to give two successive doses of 450 r. since, although the effect on the ovary is cumulative, the systemic effects of a given dose (if not lethal) are relatively short-lived. Orthotopic grafts made four weeks after irradiation proved fertile, but if grafting were delayed until nine weeks after irradiation, fertility was reduced, perhaps because of the reduced blood supply to the very atrophic ovarian remnant.

J. L. Hancock (Cambridge) has made an examination of cleaved ova recovered after natural or artificial insemination of sows in order to assess the fertilization-rates. He found 90·5 per cent cleavage after natural matings, but only 21·7–47·8 per cent after artificial insemination. The highest rates with the latter were obtained when undiluted semen or semen diluted with egg-yolk glucose phosphate diluent was used (46·2 and 47·8 per cent cleavage). When semen diluted as above but stored for twenty-four hours at 5° C. was used, the rate was only 21·7 per cent, and when semen diluted with seminal plasma was inseminated the rate was 22·2 per cent. It was also observed that the number of spermatozoa in the zona pellucida of recovered eggs was in general considerably lower after artificial insemination than after natural mating. There seems little doubt that the efficiency of artificial insemination compares unfavourably with that of natural mating.

G. I. M. Swyer

AGRICULTURE AT CAMBRIDGE

A COLLECTION of eleven review articles which have prefaced the Memoirs of the School of Agriculture, Cambridge, over the past few years has recently been published as the first volume of "Agricultural Research and Teaching at Cambridge"*. As Sir Frank Engledow points out in a foreword it is always profitable to ponder objectives and achievements of the past in deciding courses for the future, and these articles review in some detail the researches and achievements by members of the staff of the School of Agriculture in particular fields. A historical review of researches in the physiology of reproduction is made by F. H. A. Marshall in which he traces the development of this subject from the founding of a university lectureship in agricultural physiology in 1908. Kenneth Smith summarizes twenty years of virus research, and G. D. H. Bell describes how the application of genetical principles to the breeding of agricultural plants was the inspiration for the establishment of the Plant Breeding Institute in 1912. The researches in animal nutrition are reviewed by E. T. Halnan. The Horticultural Research Station was opened in 1922, and R. M. Woodman describes the changes in the character of the work which have taken place since then. The study of agricultural economics commenced as early as 1896 with the endowment of a lectureship in this subject by Sir Walter Gilbey,

* University of Cambridge: School of Agriculture. Agricultural Research and Teaching at Cambridge, Vol. 1 (comprising Review Series, Nos. 1–11). Pp. 72. (Cambridge: University School of Agriculture, 1957.) 7s. 6d.

and the late A. W. Menzies-Kitchen traces its development up to 1951. H. H. Nicholson describes the evolution of field drainage investigations which commenced in 1930 at the suggestion of Sir Frank Engledow. J. Hammond gives an account of animal production research, including the breeding experiments of Punnett which led to the establishment of the Poultry Research Station. The history of Cambridge University Farm, from the leasing of Burgoynes Farm between 1900 and 1910 and its establishment on the present site, is related by W. S. Mansfield, the director. F. Hanley details the development of crop husbandry experiments from 1894 onwards. The final review is by Sir Frank Engledow, who describes the changes in agricultural teaching at Cambridge between 1894 and 1955.

These collected reviews give a very complete picture of the progress in agricultural research at Cambridge from the end of the past century, when it was considered doubtful whether it was proper for the University to raise agriculture to the status of a Department with a chair, to the present time, when the importance of agriculture in the national economy alone is ample justification for sound teaching and research.

E. C. Humphries

NIGHT-VISION EFFICIENCY

During the Second World War the practical need arose of selecting military personnel for tasks requiring high visual performance at night, and various tests of 'night-vision efficiency' were therefore devised. The Medical Research Council initiated a study of these tests, and has recently published a report* of its findings. The report consists largely of experimental work and makes the following positive contribution to this difficult topic: absolute thresholds vary from individual to individual, and the amount of light an individual requires to perform an acuity discrimination (detecting the orientation of a Landolt *C*) and a more complex perceptual task (identifying objects in a dimly lit Hogarth print) is strongly correlated with his absolute threshold, provided that these tests are such that rods, not cones, are operative.

Minor technical criticisms can be made; for example, the frequency of positive responses to 'blank' stimuli is not reported, though this is an important index of the subject's reliability, and the figure must have been used in making the 'guessing correction' when the thresholds were determined by the procedure described in an appendix (a war-time report by H. K. Hartline and P. R. McDonald for the United States Committee on Aviation Medicine). The absolute threshold seems to be more variable than many other visual functions, such as optimum acuity, critical fusion frequency and differential threshold; it would be interesting to know why this is so, but the authors offer no experiments which throw more light on the matter. Nor have they made a serious attempt to assess the relative importance of this particular factor compared with the many other factors (for example, variations in pupil size, residual refractive error, night myopia, avoidance of foveal fixation, pattern of eye movements, reliability of response, intelligence, motivation, etc.), which may also be important in causing variations in visual performance at low illuminations. Nevertheless, a positive, well-established result is valuable in a field full of conflicting claims, and the experiments on acuity at low illuminations will interest visual physiologists.

H. B. Barlow

* Medical Research Council. Special Report Series No. 294: Individual Differences in Night-Vision Efficiency. By M. H. Pirenne, F. H. C. Marriott and E. F. O'Doherty. With a section on The Frequency of Seeing at Low Illumination by H. K. Hartline and P. R. McDonald. Pp. viii+83+1 plate. (London: H.M. Stationery Office, 1957.) 8s. net.

STATISTICAL ANALYSIS OF A RANDOM, MOVING SURFACE

A theoretical study, by Dr. M. S. Longuet-Higgins, of the statistical properties of a surface the elevation of which is given by the superposition of a large number of simple harmonic waves with random phases travelling in different directions has recently been published under the title "The Statistical Analysis of a Random, Moving Surface"*. At time t, the elevation (measured from the mean level) at a point in the surface the co-ordinates of which are (x,y) is taken to be

$$\zeta(x,y,t) = \sum_n c_n \cos(u_n x + v_n y + \sigma_n t + \varepsilon_n)$$

where the phases ε_n are distributed independently and uniformly over the interval $(0,2\pi)$, and the angular frequency

$$\sigma_n = \sigma(u_n,v_n) = \sigma(\sqrt{u_n^2 + v_n^2})$$

the function σ depending on the type of wave motion and the medium in which it takes place. In the limit as $n \to \infty$, ζ becomes a two-dimensional stationary normal stochastic process, the properties of which are completely determined by the spectral density of energy $E(u,v)$, defined by

$$\sum_{\substack{u_n \leqslant u \\ v_n \leqslant v}} \tfrac{1}{2}c_n^2 = \int_{-\infty}^{u} du' \int_{-\infty}^{v} dv' E(u',v') ;$$

the correlation function of the process is the cosine transform

$$\int_{-\infty}^{\infty} du \int_{-\infty}^{\infty} dv\, E(u,v) \cos(ux + vy + \sigma(u,v)t)$$

This has recently been used as a model for surface waves in the open ocean; the author suggests that it may also be applicable to other geophysical phenomena such as microseisms or perturbations of the ionosphere.

The main part of the study is concerned with the use of the limiting representation to derive the following properties: (1) the probability distribution of ζ and the components of slope ζ_x, ζ_y at any point; (2) the average number of zeros of ζ per unit distance along a line in an arbitrary direction in the x–y plane; (3) the average length of surface contours per unit area and the distribution of their direction; (4) the average densities of maxima, minima and 'specular' points (points where ζ_x, ζ_y take given values) per unit area; (5) the probability distribution of the velocities of zeros of ζ along a given line; (6) the probability distribution of the velocities of contours and 'specular' points; (7) the probability

* *Philosophical Transactions of the Royal Society of London*. Series A: Mathematical and Physical Sciences. No. 966, Vol. 249 (21 February 1957): The Statistical Analysis of a Random, Moving Surface. By M. S. Longuet-Higgins. Pp. 321–387. (London: Royal Society, 1957.) 21s.

distribution of the amplitude and phase of the wave envelope, defined as

$$\sum_n c_n \exp i\{(u_n - \bar{u})x + (v_n - \bar{v})y + (\sigma_n - \bar{\sigma})t + \varepsilon_n\}$$

where $\bar{u}$, $\bar{v}$, $\bar{\sigma}$ are the mean values of u, v, σ with respect to the spectral distribution $E(u,v)$. All the results are expressed in terms of quantities which are functions of the moments

$$m_{pq} = \int_{-\infty}^{\infty} du \int_{-\infty}^{\infty} dv\, u^p v^q E(u,v)$$

of the spectral distribution. Special attention is paid to the case of a narrow spectrum, for which $E(u,v)$ is only appreciable when u and v lie in narrow ranges, so that the waves are approximately uniform in wave-length and direction. This situation might occur with ocean waves arising from a single distant storm area during a not too long time interval. A result of Rice ("The Mathematical Analysis of Random Noise", *Bell System Technical Journal*, 46 ; 1945) relating to the wave envelope of a one-dimensional process can then be used to obtain an approximation to the distribution of the heights of maxima and minima of ζ.

The problem of estimating $E(u,v)$ from observational data is also considered. A method of approximating to $E(u,v)$ given the values of a finite number of moments of the energy distribution for the intersection of the surface with an arbitrary vertical plane is developed. It is shown that these moments are determined by the average numbers of zeros of ζ and its derivatives per unit distance along an arbitrary straight line, and by the mean velocities of these zeros, and hence may be estimated if values of ζ and $\partial\zeta/\partial t$ along the line are available. In the case of the sea surface it is suggested that these might be recorded by radar in an aircraft flying on a fixed course at high speed and constant altitude. No information is given about the accuracy of estimates of $E(u,v)$ made by this method. Some knowledge of the way in which the accuracy increases with the area covered by the observations for typical spectral distributions would be useful, although it might be difficult to obtain this theoretically.

A. M. WALKER

VARIABLE STARS IN THE MAGELLANIC CLOUDS

IN a recent paper on the spectra of some variable stars in the Magellanic Clouds (*Mon. Not. Roy. Astro. Soc.*, 116, 5 ; 1956), M. W. Feast, of the Radcliffe Observatory, Pretoria, gives the results of a study of spectra obtained with the *f*/2 camera of the 2-prism spectrograph (86 A./mm. at Hγ) at the Cassegrain focus of the 74-in. Radcliffe reflector. Four variables in the Small Cloud and six in the Large Cloud were selected (another star turned out to be a galactic, foreground object) and the results are tabulated in order of increasing period. Individual velocities are not published at present, but the average velocity of stars in the Small Cloud was 133 km./sec. and in the Large Cloud 274 km./sec. ; the other star, *HV* 2882, had a low velocity. The Magellanic Cloud variables appear to be normal late *F* and early *G* type supergiants, and no abnormalities were noticed nor were any emission lines found to indicate that they are Population ii (*W* Virginis) cepheids. The results are important because the work of Gascoigne and Kron (*Aust. J. Sci., Supp.*, 17, 23 ; 1954 ; and *Pub. Astro. Soc. Pacific*, 65, 32 ; 1953) led to the suggestion that the Cloud variables were in fact Population ii cepheids.

The variable *W* Men. was discovered by Luyten (see *Harvard Bulletin*, 846 ; 1927) and lies in the direction of the Large Magellanic Cloud. It is an *R* CrB.-type variable, and if it is a member of the Large Magellanic Cloud it is the only star of the class known in an extragalactic system, and the only one with a known distance and absolute magnitude. Spectroscopic criteria are the only means at present for determining the absolute magnitude of this class of variable. Owing to the faintness of the star, it was necessary to use a short trail to obtain a spectrum with the *f*/2 camera, and two spectra obtained on December 1, 1953, and February 10, 1954, were sufficiently good for certain definite conclusions to be reached. Its radial velocity is about 260 km./sec., which is in good agreement with the expected velocity for a cloud member in this position. While the spectral type is necessarily uncertain, it appears to be a supergiant of type *F*5–*G*0, most probably *F*8 with Hγ weak for the class. It may be concluded that the supergiant characteristics shown by the *R* CrB. variables are really indicators of high luminosity in these stars. Using a modulus of 19·2 mag. for the clouds, given in a paper on the distances of the Magellanic Clouds by Thackeray and Wesselink in *The Observatory* (75, 33 ; 1955), an absolute magnitude at maximum for *W* Men. of − 5·4 is deduced.

POLLEN IN TERRESTRIAL SOILS

G. W. DIMBLEBY (*New Phytol.*, 56, 12 ; 1957) has pointed out that pollen analysis of terrestrial soils, as opposed to aquatic deposits, has received surprisingly little attention, especially when it is apparent that much pollen must fall on dry ground just as it does on bog surface. The assumptions that pollen falling on soils is rapidly destroyed, or removed by downwash, or so mixed and dispersed as to be valueless in studies of vegetational history, are not necessarily well founded. In fact, he has found that pollen may be present in terrestrial soils in numbers considerably exceeding those of many peat deposits. The highest frequencies, nearly 1·5 million per gm. oven-dry soil, were recorded in mineral layers, though raw humus also gave high counts. The preservation of pollen is not satisfactory in soils of which the *p*H is above 5, but in acid soils it appears to be independent both of soil type and texture. The soil pollen content is markedly reduced by fire, and this may account for the relatively low pollen frequencies in the mineral layers of some heath soils. Acid tropical soils may contain considerable quantities of pollen, and this, together with the high values in temperate soils, suggests that the normal aerobic microbiological processes of acid soils are not so destructive of pollen as might be thought.

The distribution curve of each species of pollen through the profile assumes a characteristic form according to the length of time the pollen has been in the soil, owing to the gradual downward movement under the influence of percolating water. This movement is normally a very slow process. From the distribution patterns it is possible to outline the broad features of past vegetation changes, but interpretation is always comparative, and independent time fixes must be obtained for absolute dating.

CONGENITAL PORPHYRIA IN BOVINES: FIRST LIVING CASES IN BRITAIN

By Prof. E. C. AMOROSO, F.R.S.
Royal Veterinary College, London, N.W.1

R. M. LOOSMORE
Veterinary Investigation Officer, Ministry of Agriculture, Fisheries and Food, Veterinary Investigation Centre, Reading

AND

Prof. C. RIMINGTON, F.R.S., and B. E. TOOTH
University College Hospital Medical School, London, W.C.1

HUMAN congenital porphyria is a rare disease, only some thirty-five undoubted cases having been reported[1]. In animals, the condition was unknown until 1936, when it was discovered in a herd of cattle in Swaziland. The clinical and biochemical features were fully described by Fourie[2] and Rimington[3] and resembled closely the findings in human cases. Eventually further unrelated bovine cases were discovered in South Africa (Fourie and Rimington[4]; Fourie[5]), and later Clare and Stephens[6] reported the condition in pigs in New Zealand. Jörgensen and With[7] have more recently reported its occurrence in both pigs and bovines in Denmark. We have now observed living cases of congenital porphyria in England. Two of these have been demonstrated to the Physiological Society (Amoroso, Loosmore, Rimington and Tooth[8]).

Although the literature contains several reports of dark-coloured bones in abattoir material (see Fourie[2]) and Ross[9] has conducted a post-mortem examination upon what was almost certainly a case in the Birmingham district, these occurrences are the only ones of which we have certain knowledge. Mr. B. L. Nestel, veterinary officer in the Department of Agriculture, Jamaica, has informed one of us (C. R.) privately that in 1956 he saw in Jamaica three calves born with pink teeth and sensitive to sunlight, but unfortunately an exact diagnosis was not made while the animals were alive. Further cases of bovine congenital porphyria may, however, be occurring in a herd of Jamaica Black cattle.

Description of Cases: In July 1956, one of us (R. M. L.) was asked to see a two-year-old roan Shorthorn heifer (*A*) on a farm in Buckinghamshire. The animal had purplish-red teeth and, on being turned out in the spring for the first time, had developed on the rump and shoulders crusty sores suggestive of photosensitization. The diagnosis of congenital porphyria was confirmed a few days later as a result of further clinical and biochemical investigations; the urine and fæces were rich in porphyrins (see Table 1). From the farmer's records it was clear that he must have had two other cases in closely related heifers (*B* and *C*) born in 1951 and 1954 respectively, but the condition had not been recognized as congenital porphyria at the time. The breeding of all these animals is shown in Fig. 1. Two months after this first living case was seen, inspection of the herd revealed two more cases among the young calves. One (*D*) was a full sister of the two-year-old just described; the other (*E*) had a normal twin (*F*), and all three animals were bought

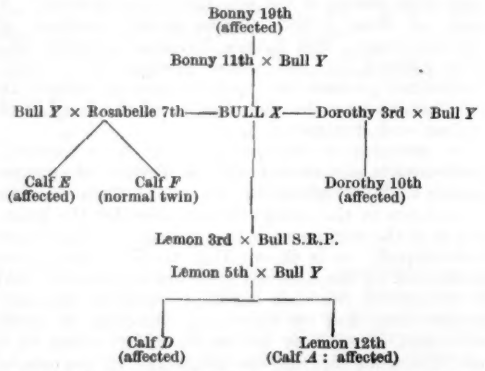


Fig. 1. Inheritance of congenital porphyria in a Shorthorn herd. Bulls *X* and *Y* must be carriers of the recessive character

for further study. Their breeding is set forth in Fig. 1. Calves *D* and *E* both have discoloured teeth and pass a pinkish urine rich in porphyrins (Table 1). The fluorescence of the teeth in ultra-violet light is fiery red, while fluorocytes are visible in the peripheral blood and are numerous in the bone marrow; blood plasma shows red fluorescence. The twin *F* shows none of these features.

Biochemical Investigations: Quantitative determinations of porphyrins in the excreta are recorded in Table 1, the control animals being the twin *F* and an unrelated calf (*G*) of approximately the same age. Paper chromatography of the isolated porphyrins (Falk and Benson[10]; Falk, Dresel, Benson and Knight[11]) established the preponderance of series I isomers. Porphobilinogen was absent from the urine and from a liver biopsy specimen, confirming that the

Table 1. Uroporphyrin, Coproporphyrin and Protoporphyrin in Excreta of Calves

Calf	Urine		Fæces		Clinical state
	Uro-porphyrin (mgm./l.)	Copro-porphyrin (mgm./l.)	Copro-porphyrin (μgm./gm.dry)	Proto-porphyrin (μgm./gm.dry)	
A	0·72–3·68	1·11–4·34	379	134	Affected
D	2·6–2·7	3·3–11·5	837	14·5	Affected
E	9·0–34·0	38–51	386–1,181	19·6–25·3	Affected
F	Nil	0·02–0·06	1·6	0·9	Normal twin of *E*
G	0·024	0·03	0·6	2·3	Normal control
	Nil	0·02			Normal dam of *A* and *D*

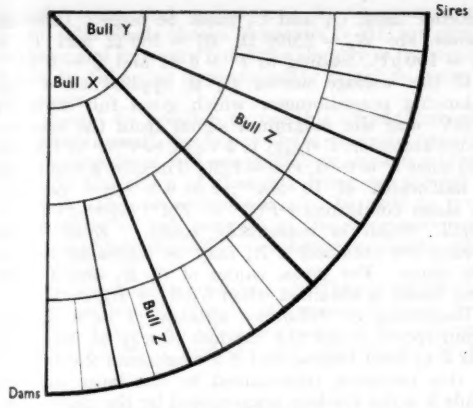


Fig. 2. Breeding of bulls *X* and *Y* showing, on the maternal side, common ancestry in bull *Z*

disturbance of porphyrin metabolism was of the 'hæmopoietic' type[12].

Hæmolysates of avian erythrocytes are known to be capable of synthesizing hæm and porphyrins *in vitro* from added glycine[13]. Human erythrocytes, although incapable of utilizing glycine, can carry the synthesis from added porphobilinogen or δ-amino-lævulic acid as far as the coproporphyrin stage (Rimington[14]), and both the uroporphyrin and coproporphyrin formed belong exclusively to the series III isomers. Normal calf blood was found to behave similarly; but when a hæmolysate, prepared from the mixed bloods of the affected animals *D* and *E*, was incubated with porphobilinogen, the uroporphyrin formed consisted of isomers I and III in about equal amounts. One of us (C. R.) has observed similar production of series I porphyrins *in vitro* from bloods of two different human cases of congenital porphyria. It is clear that the enzymic abnormality in this disease persists in the mature circulating erythrocytes and is not confined to early stages of maturation in the bone marrow.

Genetics: The herd in which these cases have occurred is one of pedigree Shorthorns and their inheritance has been relatively easy to trace. The farmer obtained bull *X* from a well-known breeder and used him on the farm for several years; he appeared in every way normal. A second bull *Y* was then obtained from the same breeder, and all the cases have occurred in crosses between *Y* and daughters of *X* (Fig. 1). In the South African material, bovine congenital porphyria was shown to be inherited as a recessive Mendelian character (Fourie[5]), and if a similar mode of inheritance were to be operating in the present instance both bulls *X* and *Y* would be carriers of the recessive gene. An examination of the stock books, kindly carried out for us by Prof. N. J. Scorgie and Mr. John David, revealed that *X* and *Y* had a common ancestor on the maternal side, the bull *Z* in Fig. 2, a circumstance which greatly strengthens the presumption that the bulls *X* and *Y* were clinically normal carriers of the recessive gene for congenital porphyria. How far the condition may be disseminated in pedigree dairy Shorthorn stock we do not know, but it would seem highly probable that further cases in such cattle will be encountered and possibly with increasing frequency.

[1] Schmid, R., Schwartz, S., and Sundberg, R. D., *Blood*, **10**, 416 (1955). Varadi, S., *J. Clin. Path.*, **9**, 384 (1956).
[2] Fourie, P. J. J., *Onderstepoort, J. Vet. Sci.*, **7**, 535 (1936).
[3] Rimington, C., *Onderstepoort J. Vet. Sci.*, **7**, 567 (1936).
[4] Fourie, P. J. J., and Rimington, C., *Onderstepoort J. Vet. Sci.*, **10**, 431 (1938).
[5] Fourie, P. J. J., *Onderstepoort J. Vet. Sci.*, **13**, 383 (1939); **18**, 305 (1943).
[6] Clare, T., and Stephens, E. H., *Nature*, **153**, 252 (1944).
[7] Jörgensen, S. K., and With, T. K., *Nature*, **176**, 156 (1955).
[8] Amoroso, E. C., Loosmore, R. M., Rimington, C., and Tooth, B. E. *Proc. Physiol. Soc.*, Dec. 15, 1956.
[9] Ross., D. B., *Vet. Record*, **69**, 343 (1957).
[10] Falk, J. E., and Benson, A., *Biochem. J.*, **55**, 101 (1953).
[11] Falk, J. E., Dresel, E. I. B., Benson A., and Knight, B. C., *Biochem. J.*, **63**, 87 (1956).
[12] Watson, C. J., *Lancet*, 539 (1951). Schmid, R., Schwartz, S., and Watson, C. J., *Arch. Int. Med.*, **93**, 167 (1954).
[13] London, I. M., and Yamasaki, M., *Fed. Proc.*, **11**, 250 (1952). Dresel, E. I. B., and Falk, J. E., *Nature*, **172**, 1185 (1953).
[14] Rimington, C., *Brit. Med. J.*, ii, 189 (1956) (Sydney Ringer Lecture).

DIFFERENCE AND DERIVATIVE SPECTRA

By Dr. A. E. MARTIN

Sir Howard Grubb, Parsons and Co., Ltd., Optical Works, Walkergate, Newcastle upon Tyne 6

DURING the past few years both difference (sometimes called differential)[1] and derivative spectra[2] have been employed to bring out details of the spectra of minor components in the presence of a strong absorption background due to basic material.

In the first method, the background absorption is cancelled out by using a double-beam spectrometer, with sample in one beam and in the reference beam a substance with closely matching background absorption but free from the minor constituent.

In the derivative method the basic absorption is eliminated to a large extent by differentiating either once or twice the d.c. output signal from the spectrometer. The effect of single and double differentiation on a typical absorption band is shown in Fig. 1, and it will be seen that the second derivative much more closely resembles the original band than does the first derivative. If a small band $A_1 = f(\nu)$, where A_1 is the absorbance and ν the frequency, is superimposed on a background represented by $A_2 = a + b\nu + c\nu^2$, a, b and c being constants, the total absorbance $A = A_1 + A_2$ and $\frac{d^2A}{d\nu^2} = 2c + f''(\nu)$, so that the effect of the background absorption disappears except for a constant displacement.

Single differentiation is effected simply by applying the signal voltage $f(\nu)$ to a capacitor C_1 in series with a resistor R_1. If the scanning rate is constant so that $d\nu/dt = r$, it is found that the voltage appearing across R_1 is

$$rR_1C_1f'(\nu) - r^2R_1^2C_1^2f''(\nu) + \ldots$$

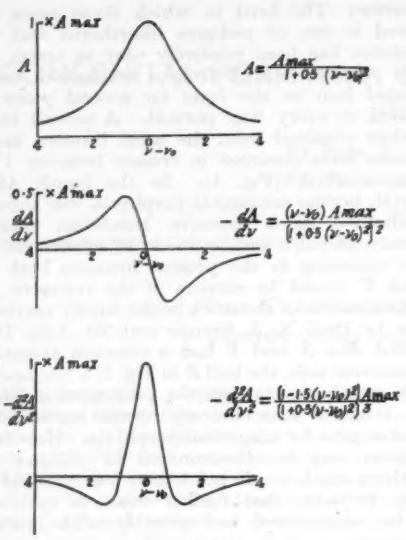


Fig. 1

To obtain a satisfactory result, rR_1C_1 must be reduced sufficiently to make the second term acceptably small.

It is the purpose of the present communication to suggest a simple means for obtaining the second derivative. The desired result is obtained by using the circuit shown in Fig. 2, and it can be shown that the voltage across R_2 is

$$r^2Pf''(\nu) - r^3PQf'''(\nu) + r^4P(Q^2 - P)f''''(\nu) - \ldots$$

where $P = R_1R_2C_1C_2$ and $Q = R_1C_1 + R_1C_2 + R_2C_2$.

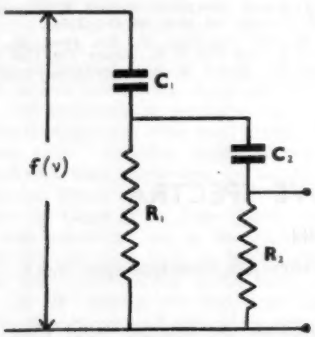


Fig. 2

For an absorption band of the general type shown in Fig. 1, $f''(\nu)_{max.} = -\frac{8Pr^2}{w^2} f(\nu)_{max.}$, where w is the half-width, that is, the frequency difference corresponding to points where $f(\nu) = \frac{1}{2}f(\nu)_{max.}$ To make the third derivative small compared with the second, rQ must be kept low, while for a given value of Q, P should be as large as possible and approach the maximum value $\frac{Q^2R_2}{4(R_1 + R_2)}$. Q should be as large as is convenient, and since R_1 and R_2 are limited by the characteristics of the spectrometer amplifier and recorder used, C_1 and C_2 must be large. Practical values are $R_1 = 2{,}000\ \Omega$, $R_2 = 500\ \Omega$ and $C_1 = C_2 = 100\ \mu F.$, leading to $P = 0{\cdot}01$ and $Q = 0{\cdot}45$.

If the voltage across R_2 is applied to a self-balancing potentiometer which gives full scale for 1 mV. and the maximum signal from the spectrometer amplifier, $f(\nu)_{max.}$, is 5 volts, $8Pr^2/w^2 = 1/5{,}000$, and since $P = 0{\cdot}01$, $r/w = 1/20$. Thus for a band with a half-width of 10 cm.$^{-1}$, $r = 0{\cdot}5$ cm.$^{-1}$ per sec. In these conditions $r^4P(Q^2 - P)f''''(\nu)/r^2\,Pf''(\nu) = 0{\cdot}023$, which is reasonably small. Even better results are obtained if R_2 may be increased beyond 500 ohms. For given values of P, R_1 and R_2, the best result is obtained when $C_2(R_1 + R_2) = R_1C_1$.

Returning to difference spectra, if in a double-beam spectrometer the incident energy at frequency ν is I in both beams, and if α represents the fraction of this radiation transmitted by the basic material while β is the fraction transmitted by the minor component, the double-beam servo system will operate to equalize the energy in the two paths so that the indicated value will be $\alpha\beta I/\alpha I = \beta$, which is the quantity required. If, however, there is a frequency shift h between the reference and sample spectra, $\alpha_1 = f(\nu)$ for the reference cell and $\alpha_2 = f(\nu + h)$ for the sample. The quantity measured, therefore, is $\beta\alpha_2/\alpha_1 = \beta f(\nu + h)/f(\nu)$. Making use of Taylor's theorem and ignoring terms higher than the second, the measured value is $\beta[1 + hf'(\nu)/f(\nu)]$ instead of β. This effect is clearly demonstrated in Fig. 3, which shows the superimposed spectra of ethylbenzene (top curve), polystyrene foil (middle curve) and finally the difference spectrum with ethylbenzene in the

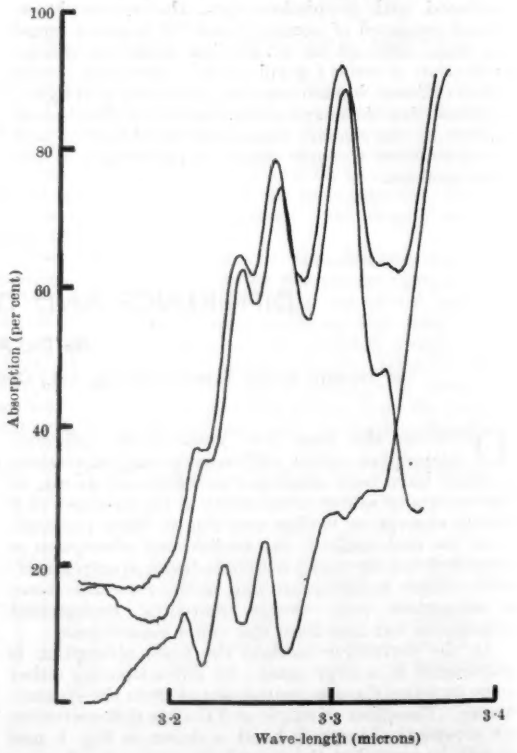


Fig. 3

sample beam and polystyrene in the comparison beam. The bands chosen (aromatic C—H) are similar in shape and intensity but differ slightly in frequency; β can be taken as approximately equal to unity in this case.

It should be possible to use this effect to measure accurately small frequency-shifts due to variation with temperature and concentration, and in addition to study the effect of changing from one solvent to another. This procedure can also be used to prove the identity of two samples of the same compound or to establish the difference between closely allied substances.

If the spectrometer records absorbance rather than transmittance, the result is presented even more directly. Let A_1 be the absorbance of the reference material ($= f(\nu)$) and A_2 the absorbance of the sample ($= af(\nu + h) + \bar{f}(\nu)$), where $af(\nu + h)$ is contributed by the basic material and $\bar{f}(\nu)$ is due to the minor constituent, if present; h denotes a frequency-shift between a band in the reference and sample materials, and a allows for possible error in matching. I_1 and I_2 denote the radiation transmitted by reference and sample, respectively, and since the double-beam balancing system weakens the reference beam until equality is reached with the sample beam, the required attenuation is I_2/I_1 and the quantity recorded is $\log I_1 - \log I_2 = A_2 - A_1 = af(\nu + h) + \bar{f}(\nu) - f(\nu) = (a - 1)f(\nu) + ahf'(\nu) + \bar{f}(\nu) = hf'(\nu) + \bar{f}(\nu)$ when $a = 1$. From the record h can be determined.

[1] Powell, H., *J. App. Chem.*, 6, 488 (1956).
[2] Collier, G. L., and Singleton, F., *J. App. Chem.*, 6, 495 (1956).

AN EFFECT OF *p*H ON THE UPTAKE OF SALT BY PLANT CELLS

By R. G. HURD* and Dr. J. F. SUTCLIFFE
Department of Botany, King's College, University of London

A NUMBER of investigators have examined the effect of *p*H value of the medium on uptake of salts by plants[1–4]. In most cases little, if any, influence has been observed over a range of *p*H values from 5 to 9. A major difficulty in the interpretation of such experiments is that buffered solutions must be employed if relatively constant *p*H values are to be maintained, and these give rise to spurious effects either by interference with the entering salt, or by influences upon metabolism which indirectly affect absorption. Such effects can be minimized by use of a buffer system, which does not contain easily absorbable ions, and is metabolically inactive. This article presents the results of some experiments to determine the effect of *p*H on the absorption of salts by parenchyma cells of various storage organs, using such a buffer system (*tris*-hydroxymethylaminomethane + sulphuric acid).

In an experiment with red beet root tissue, it was found that the rate of absorption of potassium ions from a 0·0024 *M* solution of potassium chloride was much greater at *p*H 8·5 than at *p*H 6 (Fig. 1). The rate of uptake of chloride, however, was approximately the same at the two *p*H values. Consequently, whereas the rate of absorption of chloride was only slightly lower than that of potassium at *p*H 6, considerably more potassium ions than chloride were absorbed at *p*H 8·5. The buffer components of the medium were essentially inactive in this experiment since, as Fig. 1 shows, the uptake of salt from an unbuffered control solution, with a *p*H value of about 6, was approximately the same as that from the buffered solution at *p*H 6. Evidence is also available, although it is not presented here, showing that the buffer probably did not interfere significantly with the uptake of salt from the alkaline solution.

When the experimental period was extended beyond 72 hr., it was observed that potassium absorption from the alkaline solution continued to exceed the uptake of chloride until the tissue became saturated with salt. When both tissues were saturated, the total amount of potassium in the disks at *p*H 8·5 was approximately twice that held by the disks in the acid solution.

The magnitude of these effects on both the relative uptake of the two ions, and the amounts of salt held in the tissue at saturation, varied somewhat with the concentration of salt in the medium. No stimulation of potassium uptake at the alkaline *p*H from a solution of 0·024 *M* potassium chloride was observed until about 12 hr. after absorption commenced. Afterwards, uptake at *p*H 8·5 exceeded that at *p*H 6, and the amount of potassium held by the tissue at saturation was greater in the former solution. How-

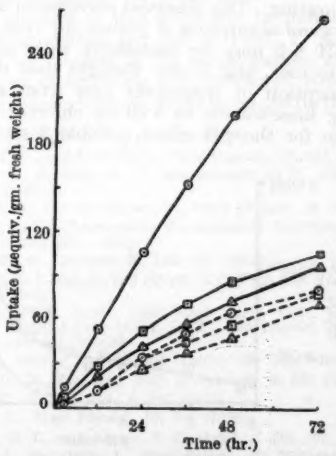


Fig. 1. Amounts of K^+ and Cl^- absorbed by washed beet slices at 18° C. from 0·0024 *M* potassium chloride solutions at *p*H 6. ⊡, Buffered; △, unbuffered; and at *p*H 8·5, ⊙, buffered. Full line refers to potassium, pecked line to chloride

* Present address: W.A.C.R.I., Tafo, Ghana.

ever, the effects were, in each case, smaller than those observed in experiments with salt solutions at a lower concentration. This was attributable mainly to a greater effect of increased concentration in promoting the uptake of both potassium and chloride ions at *p*H 6 than at *p*H 8·5. The amount of salt held by the tissue at saturation was unaffected by concentration at *p*H 8·5, but more potassium and chloride ions were present in tissue kept at *p*H 6 in 0·024 *M* potassium chloride than in 0·0024 *M* potassium chloride (Table 1).

Table 1. Amounts of K^+ and Cl^- (μequiv./gm. fresh wt.) held by red beet root disks at saturation from solutions of 0·0024 *M* potassium chloride and 0·024 *M* potassium chloride at *p*H 6 and *p*H 8·5 (temperature = 18° C.). Results are means of several experiments

Concentration	Ion	*p*H 6	*p*H 8·5
0·0024 *M*	K^+	160	293
	Cl^-	83	82
0·024 *M*	K^+	196	294
	Cl^-	116	86

The degree of stimulation of cation absorption induced at the alkaline *p*H also varied between different kinds of tissues. The greatest stimulation was obtained with phloem tissue from parsnip roots; white beet root tissue, artichoke tuber tissue and carrot tissue (phloem and xylem parenchyma) showed effects similar in magnitude to those obtained with red beet. A significant effect was also obtained on intact barley seedlings. On the other hand, the rate of absorption of potassium by slices of potato tuber tissue and swede hypocotyl tissue (outer xylem) was the same at *p*H 8·5 as it was at *p*H 6.

It has been found that the effects of *p*H observed in these experiments were related to the presence of bicarbonate ions in the alkaline solutions, and to the ability of some tissues to absorb these ions. Over a part of the *p*H range examined, the amount of potassium ions taken up in 6 hr. at 25° C. by red beet tissue increased proportionately with the retentivity of carbon dioxide as bicarbonate ions in the solutions (Fig. 2). At the highest *p*H values (8–9), however, it is evident that some factor other than the amount of bicarbonate ions in the solution becomes limiting. The observed correlation indicates that the excess absorption of potassium over chloride ions at *p*H 8·5 may be associated with uptake of bicarbonate ions, and it was thought that the more rapid absorption of potassium ions from solutions containing bicarbonate as well as chloride may be responsible for the *p*H effect. Table 2 shows that

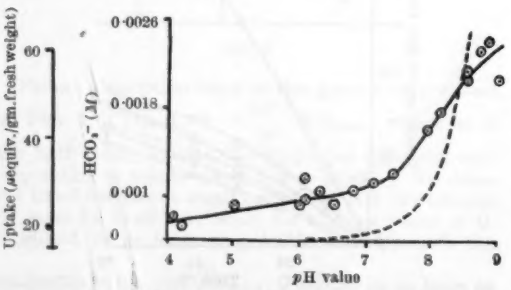


Fig. 2. Uptake of potassium ions by washed beet slices in 6 hr. at 25° C. from 0·0024 *M* potassium chloride solutions at different *p*H values (full line); and the (theoretical) amounts of HCO_3^- retained in solution under the same conditions (pecked line)

Table 2. Amounts of K^+ (μ equiv./gm. fresh wt.) taken up in 21 hr. by various tissues at 25° C. from unbuffered solutions of (*a*) 0·0024 *M* potassium chloride; (*b*) 0·0024 *M* potassium bicarbonate; and (*c*) 0·0012 *M* potassium bicarbonate + 0·0012 *M* potassium chloride

Tissue	*a*	*b*	*c*
Red beet	30·0	41·5	44·0
Parsnip	29·0	85·5	81·0
Swede	88·0	67·5	81·5

the uptake of potassium by red beet and parsnip tissue proceeded more rapidly from a solution of potassium bicarbonate, or from a solution containing both potassium chloride and potassium bicarbonate, than from a solution of potassium chloride, when all the solutions had initially the same potassium content. Swede tissue, on the other hand, absorbed potassium less rapidly from a potassium bicarbonate solution than from a solution containing potassium chloride.

In this experiment the solutions were not buffered, and did not have exactly the same initial *p*H value, so that *p*H could have been directly influencing the result. However, the uptake of potassium from potassium bicarbonate solutions reduced to *p*H 6 with sulphuric acid was found to be greater than that from potassium chloride solutions buffered at the same *p*H. It is therefore concluded that the presence of bicarbonate ions was the important factor promoting the uptake of potassium from alkaline solutions.

This experiment demonstrated that potassium uptake is stimulated by the presence of bicarbonate ions in tissues capable of showing a *p*H effect; this does not necessarily mean that bicarbonate ions are absorbed, although uptake is strongly indicated. It is well established that bicarbonate is not accumulated as such by plant cells[5] and it is sometimes implied that they are not even absorbed[6]. Some fixation of bicarbonate ions by excised barley roots was, however demonstrated by Overstreet *et al.*[7] using carbon-11-labelled bicarbonate. More recently, Kadry[8] has claimed that there is a marked accumulation of carbon derived from bicarbonate in several plants. We have found, using carbon-14-labelled bicarbonate, that bicarbonate ions are taken up by beet disks in equivalent amounts to the sodium ions absorbed from a sodium bicarbonate solution (Table 3).

Table 3. Amounts of N^+ and HCO_3^- (μequiv./gm. fresh wt.) taken up by red beet disks in 6 hr. at 18° C. from 0·0012 *M* $NaH^{14}CO_3$ solutions after pretreatment for 1 hr. in unlabelled 0·0012 *M* sodium bicarbonate. Uptakes of HCO_3^- based on radioactivity measurements on (*a*) the external medium; (*b*) the tissue

Replicates	Na^+	HCO_3^- (*a*)	HCO_3^- (*b*)
Exp. *A* 1	8·3	7·0	9·0
2	7·0	6·5	5·5
Exp. *B* 1	4·5	4·5	5·0

Other tissues, including swede and potato, will take up bicarbonate ions from solutions of potassium or sodium bicarbonate, but whereas those tissues capable of showing a *p*H effect will absorb bicarbonate also in the presence of chloride, those not showing the *p*H effect will not readily absorb bicarbonate when chloride is present if the two are supplied in equimolar amounts (Fig. 3). This latter observation may account for the absence of a *p*H effect in potato and swede tissues.

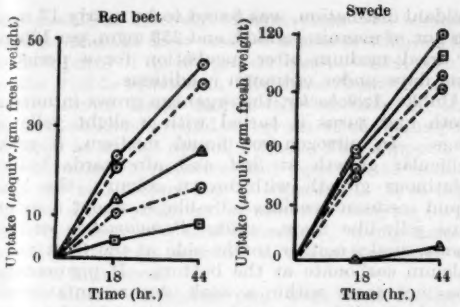


Fig. 3. Uptake of ions by red beet root tissue, and swede hypocotyl tissue, at 18° C. from unbuffered solutions of 0·0024 *M* KCl (⊙—·—⊙, K^+ uptake); 0·0024 *M* $KHCO_3$ (⊙— —⊙, K^+ uptake); and 0·0012 KCl + 0·0012 *M* $KHCO_3$ (⊙——⊙, K^+ uptake; ▲——▲, HCO_3^- uptake; ⊡——⊡, Cl^- uptake)

When bicarbonate ions are absorbed, few, if any, remain as such in the tissue. We have shown by paper chromatography that most of the bicarbonate is converted in beet tissue into various organic acids, particularly malic acid.

It may be concluded, therefore, that the apparently unequal uptake of cations and anions observed with some tissues from solutions of potassium chloride at *p*H 8·5 is in reality an equal uptake of positively and negatively charged particles. The sum of chloride and bicarbonate ions absorbed in a given time is equivalent to the amount of potassium ions taken up. This is possibly also the case with the same tissues at *p*H 6, and, since fewer bicarbonate ions are available in acid solutions, the smaller difference between the rate of potassium and chloride uptake is understandable (Fig. 1).

The conclusion that cations are absorbed in association with bicarbonate ions is of interest in another connexion. Ulrich[9] observed that when an excess uptake of cations over anions occurs in barley roots (for example, when absorption takes place from a solution of potassium sulphate), there is an increase in the organic acid content of the tissue. Ulrich looked upon this as a device to maintain electrical neutrality following unequal uptake of oppositely charged particles. Lundegårdh[10], on the other hand, believed that synthesis of organic acid anions was the cause rather than the effect of an excess absorption of cations. In terms of the hypothesis outlined above, under the particular conditions in which apparent unequal uptake occurred in the present experiments, bicarbonate ions are absorbed in association with some of the potassium ions taken up, and are converted into organic acid anions which serve to maintain electrical neutrality within the tissue. An accumulation of bicarbonate ions in the tissue could presumably accomplish the same end, but apparently this does not occur for reasons which are unknown.

It seems unlikely that the concomitant absorption of bicarbonate ions can account entirely for all cases of apparent excess cation uptake observed in plants. In acid solutions, where negligible amounts of bicarbonate ions are presumably present, an excess absorption of cations may occur from certain salts such as potassium sulphate[9]. In these circumstances it seems probable that organic acid anions appearing within the tissue are derived mainly, not from absorbed bicarbonate, but from carbon dioxide. The uptake of carbon dioxide by roots and its fixation as organic acids has been demonstrated by Poel[11] and Jacobson[12]. Jacobson noted a qualitative relationship between the amount of carbon dioxide fixed and the excess cations accumulated by excised barley roots from solutions of various salts. When organic acids are derived from carbon dioxide, the excess cations presumably enter in exchange for hydrogen ions produced by dissociation of the organic acid molecules synthesized. Carbon dioxide fixation cannot account for the observations made in the present experiment, because the greatest effects were found in alkaline solutions which did not contain more dissolved carbon dioxide than did the acid media.

Finally may be considered the less common situation in which an excess of anions over cations is absorbed. Hoagland and Broyer[13] observed a qualitative lowering of the organic acid content of barley roots placed in solutions of calcium bromide, and subsequent workers[9,14] have confirmed this effect. In every case the decrease in amount of organic acid was small, and it is possible that these anions were lost in exchange for the excess bromide absorbed. A more likely explanation seems to be that exchange occurred between internal bicarbonate and external bromide ions. The carboxylating reaction by which bicarbonate is converted to organic acids is likely to be reversible, and will have a definite equilibrium constant. If external anions exchange with bicarbonate ions present in the cell, organic acids will break down to renew the equilibrium. In cases of excess anion uptake by storage tissues, it has been observed that bicarbonate ions appear in the medium in equivalent amounts to the excess anions accumulated[15]. Thus it may be concluded that the examples of unequal uptake of anions and cations by plant cells are likely to be more apparent than real. The concomitant uptake or loss of bicarbonate ions (or carbon dioxide) is likely to be responsible for changes in the organic acid content of the tissue during apparent unequal uptake. No influence of *p*H as such on anion accumulation was detected in any of the tissues examined. This observation makes it unlikely that a mechanism of the type $A^- + ROH \rightleftharpoons RA + OH^-$ as visualized by Jacobson, Overstreet, King and Handley[16] operates in the absorption of anions by these cells.

A full account of this work will be published elsewhere. Our thanks are due to Prof. T. A. Bennet-Clark for his interest in the investigation, and to the Department of Scientific and Industrial Research for providing a maintenance grant to one of us (R. G. H.).

[1] Petrie, A. H. K., *New Phyt.*, **37**, 211 (1938).
[2] Steward, F. C., and Preston, C., *Plant Physiol.*, **16**, 481 (1941).
[3] Arnon, D. I., Fratzke, W. E., and Johnson, C. M., *Plant Physiol.*, **17**, 515 (1942).
[4] Nielsen, T. R., and Overstreet, R., *Plant Physiol.*, **30**, 303 (1955).
[5] Hoagland, D. R., "Lectures on the Inorganic Nutrition of Plants", 132 (Chronica Bot., 1944).
[6] Lundegårdh, H., *Biochem. Z.*, **290**, 104 (1937).
[7] Overstreet, R., Ruben, S., and Broyer, T. C., *Proc. U.S. Nat. Acad. Sci.*, **26**, 688 (1940).
[8] Kadry, L., Ph.D. thesis, Utah State Agric. Coll., Logan, Utah (1954). (Quoted from Miller, G. W., and Thorne, D. W., *Plant Physiol.*, **31**, 151 (1956).)
[9] Ulrich, A., *Amer. J. Bot.*, **28**, 526 (1941); **29**, 220 (1942).
[10] Lundegårdh, H., Soc. Exp. Biol. Symposium, **8**, 262 (1954).
[11] Poel, L. W., *J. Exp. Bot.*, **4**, 157 (1953).
[12] Jacobson, L., *Plant Physiol.*, **30**, 264 (1955).
[13] Hoagland, D. R., and Broyer, T. C., *Amer. J. Bot.*, **27**, 173 (1940).
[14] Jacobson, L., and Ordin, L., *Plant Physiol.*, **29**, 70 (1954).
[15] Steward, F. C., Stout, P. R., and Preston, C., *Plant Physiol.*, **15**, 409 (1940).
[16] Jacobson, L., Overstreet, R. King, H. M., and Handley, R., *Plant Physiol.*, **25**, 639 (1950).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Type of Nitrogen-fixing Bacterium

In the course of an investigation in the Jute Agricultural Research Institute on nitrogen transformation in soils cropped with jute, a nitrogen-fixing bacterium has been isolated by the dilution-plate technique. It shows certain morphological and physiological differences from the known non-symbiotic nitrogen-fixing organisms like *Pseudomonas azotocalligans* and those belonging to the Azotobacteriaceae[1]. The cells at first have a coccus-like appearance and occur singly (measuring 0·75–1·0 × 1·5–2·5μ on an average) or as doublets or triplets, gradually changing to rod shape (Fig. 1). The cells are Gram-negative; they contain fat and are very difficult to suspend in water. The optimum temperature for growth was found to be about 28° C. The organism is aerobic, but can be grown under low oxygen tension in Winogradsky's nitrogen-free glucose–phosphate media. It can grow in acidic media also; even at *p*H 4·0 growth was obtained. Bromo-cresol purple milk (skimmed) is turned alkaline and a sediment is formed at the bottom with a clear liquid surface after ten days incubation at 30° C.

Colonies on Ashby's nitrogen-deficient agar are raised, and are usually oval with mean diameters of 4·6 × 3·3 mm.; but some, especially of the larger colonies, may be pulvinate. At first the colonies are transparent with a yellow tinge, but in three or four days they turn chocolate brown and finally become gelatinous. On Winogradsky's glucose peptone agar, colonies appear earlier but grow more slowly than on Ashby's agar. On the former medium the colonies, when young, have chocolate centres and white shiny edges but gradually become grey or colourless. On potato dextrose agar slants, chocolate-brown colonies develop within two days. The pigment does not diffuse into the medium and is insoluble in water and in alcohol. But under low oxygen tension, the colonies appear somewhat like water-drops without any pigment.

The nitrogen fixed in Ashby's nitrogen-free agar–mannitol medium, when estimated by semi-micro-kjeldahl distillation, was found to be nearly 17 mgm. per gm. of mannitol added, and 253 mgm. per 100 gm. of dried medium after incubation for a period of nine days under optimum conditions.

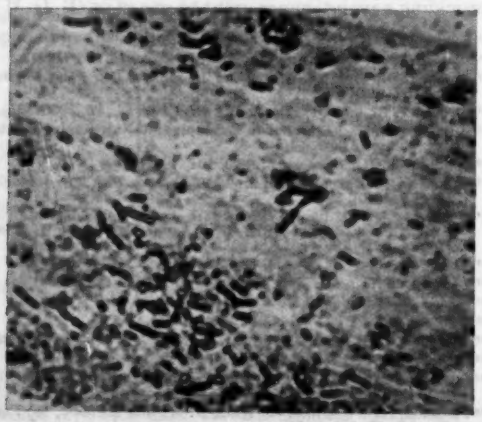


Fig. 1. A new nitrogen-fixing bacterium. × 1,500

Unlike *Azotobacter*, the organism grows in nutrient broth and turns it turbid with a slight yellowish tinge. In nitrogen-free liquid medium, it makes pellicular growth at first and afterwards bulbous gelatinous growth with brown colour; the entire liquid medium becomes jelly-like in about a month. This jelly-like mass, unlike *Pseudomonas azotocalligans*, sticks neither to the side of the flask nor to calcium carbonate at the bottom. If pigmentation does not occur within a week, due to unfavourable growth conditions, no pigmentation develops even on prolonged keeping.

The organism utilizes carbohydrates, especially glucose and mannitol. It has been found that whatever be the source of the energy material, practically no growth is obtained with inorganic nitrogen compounds (either ammonium or nitrates). Further work is in progress.

We thank Dr. B. C. Kundu, director of the Jute Agricultural Research Institute, Barrackpore, for his help during this work.

A. B. Roy
M. K. Mukherjee
Jute Agricultural Research Institute,
Barrackpore,
West Bengal, India.

[1] Anderson, G. B., *J. Bact.*, **70**, 129 (1955). Jenson, H. L., *Bact. Rev.*, **18**, 195 (1954). Bergy's "Manual of Determinative Bacteriology" (Baillière, Tindall and Cox, 1948).

An Albino Strain of the Desert Locust

During extensive laboratory breeding of the desert locust *Schistocerca gregaria* (Forskål), at the Chemical Defence Experimental Establishment, Porton, twelve albino hoppers (nymphs), creamy-white in colour, occurred among the normal heavily pigmented ones. Six were males and six females, and from them an albino strain has been established in the laboratory of the Anti-Locust Research Centre.

The coloration of normal *Schistocerca* hoppers reared in crowds (phase *gregaria*) consists of a heavy black pattern on a white or yellow ground, while that of young adults is predominantly pink. The pink changes to yellow or straw as the adults become sexually mature. Hoppers of the albino strain reared in crowds, however, do not develop the black pattern, and the adults are almost uniformly ivory-white, becoming yellow on maturation. Goodwin[1] showed that the black pattern of normal *Schistocerca* is due to melanin and the pink colour to insectorubin, and suggested that these two pigments are metabolically interrelated. This suggestion appears to be supported by the apparent absence of melanin from the albino hoppers, although a small amount of insectorubin is present (Goodwin, personal communication).

Schistocerca hoppers reared in isolation (phase *solitaria*) are typically green with little or no black pattern, and they contain neither melanin nor insectorubin[1]. Albino hoppers similarly reared also develop this green colour, without black pattern. Thus, under conditions of isolation, hoppers of the normal and albino strains are indistinguishable.

Nickerson[2] suggested that phase coloration in *Schistocerca gregaria* is controlled by two hormones, one controlling the extent of the black pattern and the other controlling the background colour. He

was unable to discover whether these two hormones were separate in their mode of action or whether they formed parts of an integrated system which resulted in the visible coloration. Evidence from the albino strain shows that, despite the absence of black pattern, the background colour shows the same phase changes as in the normal strain. This supports the two-hormone hypothesis and appears to indicate that the two factors can be separated. It is hoped that the albino strain can be used for clarifying further the physiology of phase coloration; living material would be willingly supplied to research workers who may be interested.

The albino strain has now been bred to the F_7 generation without the appearance of any individuals of the normal type and without any loss of vigour. Crosses between albino and normal adults show a Mendelian pattern of inheritance, in which albinism is recessive.

I wish to thank Mr. R. D. MacCuaig for his kindness in sending me the twelve original albino hoppers.

PHILIP HUNTER-JONES

Anti-Locust Research Centre,
1 Princes Gate,
London, S.W.7.

[1] Goodwin, T. W., *Biol. Rev., Cambridge*, **27**, 439 (1952).
[2] Nickerson, B., *Anti-Locust Bull., Lond.*, No. 24 (1956).

Sclerotization and Melanization: Two Independent Processes in the Cuticle of the Desert Locust

CONSIDERABLE advances in our knowledge of sclerotin formation in the insect integument have been accompanied by little progress in our understanding of melanin formation. This seems to be due to confusion between the two processes of sclerotization and melanization.

The cuticle of the last nymphal instar of the desert locust, *Schistocerca gregaria* (Forskål), is pale and not amber-coloured, although, like that of the cockroach *Periplaneta*[1], it appears to be phenolically tanned. It contains melanin only in well-defined patches. A critical study of melanin formation in this cuticle has led to two important conclusions. First, melanization and sclerotization are two independent processes, as was suggested by Goodwin[2]. Each appears to involve its own copper-protein phenolase. Secondly, the two processes are consecutive in the melanized areas, sclerotization being delayed until melanin formation has been completed. Hitherto it does not seem to have been unequivocally shown that darkening of an insect exoskeleton may not be accompanied by tanning.

In the soft cuticle newly exposed on moulting, a copper-protein phenolase occupies the entire thickness of the presumptive exocuticle (*A*, Fig. 1). This enzyme appears to be identical with that responsible

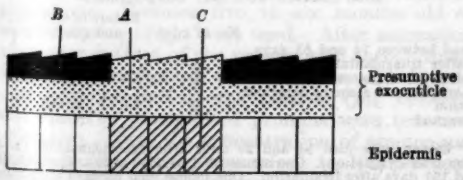


Fig. 1. Normal nymph

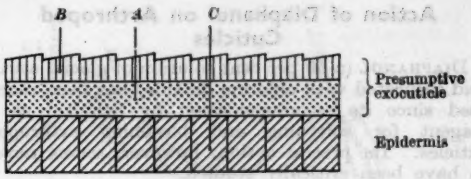


Fig. 2. Albino nymph

for hardening in the cockroach ootheca[3], in the puparium of *Sarcophaga*[4] and in the cuticle of *Periplaneta*[5]. That it is indeed concerned with hardening is indicated by its absence from the arthrodial membranes, which remain soft throughout the instar. A similar, but more highly reactive, phenolase (*B*, Fig. 1) occupies only those regions of the exocuticle in which melanin is destined to be formed. Attempts to distinguish critically between the two enzymes have been only partly successful. Both activate the same substrates, but differ in the intensity of their action and in the extent to which they are inhibited by the usual phenolase inhibitors.

Closely correlated with this difference in enzyme activity is the distribution of phenolic material in the epidermis at the onset of the hardening process. In unpigmented areas, strongly reducing material (*C*, Fig. 1) accumulates in the epidermal cells and may represent diphenolic compounds. In pigmented areas, on the other hand, no such material is apparent in the epidermal cells. It is remarkable that the cuticle, at the same developmental stage, is itself slightly argentaffin only in the unpigmented areas. Elsewhere it is not argentaffin, but becomes so after melanin formation has been completed.

The reason why melanin is not formed in the cuticle of the albino strain of the same species of locust[6] may now be referred to. Surprisingly, the highly active phenolase concerned in melanin formation is not lacking (*B*, Fig. 2), but is uniformly distributed throughout the outer zone of the presumptive exocuticle. Nor are diphenols absent from the cuticle, for I have extracted from the exuviæ of albino nymphs the same diphenols (including protocatechuic acid and dihydroxyphenylacetic acid) as from the cuticles of the normal strain. But reducing substances accumulate at the onset of hardening throughout the whole epidermis of the albino locusts (*C*, Fig. 2), just as they do in non-melanized areas of the normal strain, and it may be suggested that failure to form melanin, whether in the pale areas of the cuticle of normal nymphs or in the whole cuticle of albinos, may be due to the withholding by the epidermis of the necessary chromogen.

These observations were made during an investigation into the cuticle of the desert locust carried out at the University of Manchester and supported by the Anti-Locust Research Centre. A full report is being prepared.

S. R. A. MALEK

Department of Zoology,
Faculty of Science,
Alexandria University.

[1] Dennell, R., and Malek, S. R. A., *Proc. Roy. Soc.*, B, **142**, 126 (1954).
[2] Goodwin, T. W., *Biol. Rev., Cambridge*, **27**, 439 (1952).
[3] Brunet, P. C. J., *Quart. J. Micro. Sci.*, **93**, 47 (1952).
[4] Dennell, R., *Proc. Roy. Soc.*, B, **134**, 79 (1947).
[5] Malek S. R. A., *Nature*, **170**, 850 (1952).
[6] Hunter-Jones, P. (preceding communication).

Action of Diaphanol on Arthropod Cuticles

Diaphanol (a 50 per cent solution of glacial acetic acid saturated with chlorine dioxide) has been much used since its recommendation by Schulze[1] as a reagent for softening and bleaching arthropod cuticles. Its precise action, however, seems never to have been critically studied.

Chromatographic examination of cuticles of the adult cockroach *Periplaneta americana* after treatment with diaphanol reveals that after only a comparatively short time of 24 hr. the aromatic amino-acids have been destroyed. Prolonged treatment results in complete removal of all ninhydrin-positive material. Cuticles, after treatment with diaphanol, were hydrolysed with 6 *N* hydrochloric acid for 20–24 hr. and the hydrolysate evaporated to dryness, the residue being taken up in 10 per cent *iso*-propyl alcohol. Two-dimensional chromatograms were developed using butanol / acetic acid / water and aqueous phenol as solvents, the amino-acids being detected by spraying with a solution of ninhydrin in butanol. After treatment for 24 hr. with diaphanol both *ortho*- and *para*-tyrosines were absent, and proline also had been partially eliminated. After treatment for 6 weeks, only very minute quantities of ninhydrin-positive material could be detected after hydrolysis, and the spots on the chromatogram corresponded with glycine and aspartic acid. After treatment for 8 weeks no ninhydrin-positive material remained.

In tests carried out on the effects of diaphanol on individual amino-acids, it was found that after 18 hr. phenylalanine had been partially broken down, some alanine being present in the solution. After 3 days, all ninhydrin-positive material had been removed from the solution. When a mixture of tryptophan, *ortho*-tyrosine, *para*-tyrosine, proline, threonine, methionine, valine and glycine was placed in diaphanol the aromatic acids had disappeared after 18 hr. and proline was reduced in amount. All the acids had been destroyed after 5 weeks. As aromatic substances are responsible for tanning in many arthropod cuticles[2] the changes caused by diaphanol treatment are readily explained by its action on aromatic nuclei and individual amino-acids.

Diaphanol is stated to be a useful reagent for softening and bleaching chitinous materials but "has the disadvantage that it often spoils histological detail"[3]. This is not surprising in view of its action on amino-acids in general.

These observations were made while studying amino-acid metabolism in the cockroach *Periplaneta americana*.

J. Kennaugh

Department of Zoology, The University,
Manchester 13. April 5.

[1] Schulze P., *Sitz. Ber. Ges. Naturf. Freunde Berlin*, 135 (1921).
[2] Pryor, M. G. M., *Proc. Roy. Soc.*, B, **128**, 393 (1940). Pryor, M. G. M., Russell, P. B., and Todd, A. R., *Nature*, **159**, 399 (1947).
[3] Bolles Lee, "Microtomist's Vade-Mecum", 11th edit., p. 341.

Surviving Rat Skin Grafts in Mice

Until recently, orthotopic transplantation of heterologous normal tissue could not be achieved in mammals. In 1956 it was demonstrated independently by Nowell *et al.*[1], Ford *et al.*[2] and Vos *et al.*[3] that a persistent proliferation of rat hæmatopoietic cells occurs in mice which survive a lethal total body dose of X-rays as the result of the administration of rat bone-marrow. More than one year after the transplantation in some of these mice all the erythrocytes and granulocytes were found to be of rat origin[4].

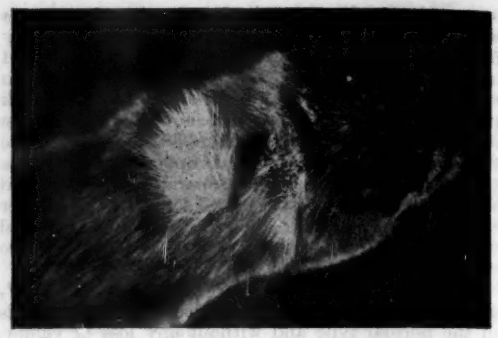


Fig. 1. Functiona lrat skin grafts in a mouse, 28 days after transplantation, 151 days after irradiation. This mouse died during anæsthesia

It seemed of interest to investigate whether these radiation-chimæras would accept skin grafts of the bone-marrow donor species. In the case of homologous bone-marrow transplantation in irradiated mice, successful grafting of the skin of the bone-marrow donor strain has been reported by Trentin[5]. The use of heterologous bone-marrow transplants permits a regular evaluation of the functional state of the marrow graft by identification of the erythrocytes and granulocytes[4]. Unfortunately the relatively high mortality which occurs in mice treated with rat bone-marrow limits the number of available animals.

In the present experiments irradiated *CBA* and F_1 (*CBA* ♂ × *C57 Bl* ♀) mice were protected with bone-marrow from an inbred rat strain (Wistar Albino Glaxo). The X-ray dose varied between 675 and 800 r. In 35 of the surviving mice small pieces of rat skin have been grafted at 24–151 days following the irradiation (Table 1). The method of free skin grafting[7] was used. In preliminary experiments, rat skin transplants into non-irradiated mice (37 cases) were found to slough within 12 days after the grafting.

At present, rat skin of a completely normal aspect is growing in 10 mice (Fig. 1). These grafts are between 52 and 108 days old. All the erythrocytes and granulocytes of the recipients are of rat origin. In nine cases the rat skin grafts are deteriorating. These hosts have a mixed population of rat and mouse erythrocytes and granulocytes. Sloughing of the rat skin grafts has been observed in three cases. In these mice no rat cells were found in the peripheral blood.

Table 1. Survival of Rat Skin Grafts in Lethally Irradiated Mice treated with Rat Bone-Marrow

	No. of mice	Nature of erythrocytes and granulocytes
Dead between 14 and 63 days after transplantation	13*	—
Takes, showing normal rat skin	10	rat
Takes, in some stage of deterioration	9	mixed
Sloughed	3	mouse

* Eleven mice died 14 and 28 days after transplantation (30–59 days after irradiation). One mouse died 28 days after transplantation and 151 days after irradiation. One mouse died 63 days after transplantation and 88 days after irradiation.

Homologous (*C57 B1*) skin was grafted simultaneously with rat skin in 19 of the mice protected with rat bone-marrow and used in this study. In four of these cases the rat skin graft has taken excellently, while the homologous skin sloughed between 10 and 30 days after the transplantation. This may have been due to a production of antibodies, either by the foreign bone-marrow or by the host. The observation that irradiated mice which have been protected by F_1 marrow accept skin grafts of the other parent strain[3] points to the latter possibility.

Of the rat skin grafted radiation-chimæras 13 have died between 14 and 63 days after the transplantation. In all cases except one the skin graft appeared healthy at the time of death. In the older grafts a regrowth of hair had occurred.

O. Brocades Zaalberg
O. Vos
D. W. van Bekkum

Medical Biological Laboratory of the
National Defence Research Council,
139 Lange Kleiweg,
Rijswijk-Z.H.,
The Netherlands.
April 4.

[1] Nowell, P. C., Cole, L. J., Habermeyer, J. G., and Roan, P. L., *Cancer Research*, **16**, 258 (1956).
[2] Ford, L. E., Hamerton, J. L., Barnes, B. W. H., and Loutit, J. F., *Nature*, **177**, 452 (1956)
[3] Vos, O., Davids, J. A. G., Weyzen, W. W. H., and Bekkum, D. W. van, *Acta Physiol. Pharmacol. Neerl.*, **4**, 482 (1956).
[4] Cohen, J. A., Vos, O., and Bekkum, D. W. van, Proceedings of the Radiobiological Conference held in 1956 at Stockholm (in the press).
[5] Trentin, J. J., *Proc. Soc. Exp. Biol. Med.*, **93**, 688 (1956)
[6] Bekkum, D. W. van, Vos, O., and Weyzen, W. W. H., *Revue d'Hématologie*, **11**, 477 (1956).
[7] Billingham, R. E., and Medawar, D. D., *Brit. J. Exp. Biol.*, **28**, 385 (1951).
[8] Main, J. M., and Prehn, R. T., *J. Nat. Canc. Inst.*, **15**, 1023 (1955).

Amino-Acid Composition of Adult and Fœtal Myoglobin of the Cow

In recent years some investigators have searched for a fœtal type of myoglobin[1–4]. The results obtained by Jonxis and Wadman[2] and Rossi-Fanelli and co-workers[3] suggest that some differences exist between the myoglobins of the adult and fœtal cow, particularly as regards resistance against alkali, solubility and ultra-violet spectral absorption. By using paper electrophoretic techniques, Singer *et al.*[4] showed the probable existence of a fœtal type of this muscle pigment in human beings. However, a sharp characterization of these fœtal proteins has not yet been accomplished. In this communication we report some experiments concerning the paper electrophoretic behaviour and the amino-acid composition of the adult and fœtal myoglobin of the cow.

For the preparation of the myoglobins the technique described by Boardman and Adair[5] was used with some modifications. Fœtuses five to six months old of cows of Friesian origin were used. After saturation of the water extract of the muscle with carbon monoxide, solid ammonium sulphate was added until 65 per cent saturation was reached (*p*H between 6 and 7). The precipitated proteins were removed by filtration. Next the concentration of ammonium sulphate in the filtrate was raised to 100 per cent saturation. The precipitate was dissolved in a small volume of distilled water and dialysed against a large volume of a 75 per cent saturated solution of ammonium sulphate. The concentration of the ammonium sulphate was gradually increased to 85 per cent saturation. The purity of the myoglobin remaining in solution was estimated by measuring the spectral absorption between 500 and 600 mμ after reduction with sodium dithionite and saturation with carbon monoxide (maximal adsorption[6] of carboxy myoglobin at 540 mμ). As shown in Fig. 1 a maximum of 576–578 mμ was reached after 85 per cent saturation. The myoglobin was again precipitated by raising the concentration of ammonium sulphate to 100 per cent saturation. The precipitate was dissolved in a small volume of distilled water and dialysed, first against water for 48 hr. and next against a 0·025 *M* citrate buffer solution *p*H 6·0 (sodium ion concentration, 0·075). An aliquot of this solution was subjected to chromatography on a column 10 cm. × 1·5 cm. of 'Amberlite *IRC* 50' (*XE* 64) using a 0·05 *M* citrate buffer solution *p*H 6·0 (sodium ion concentration, 0·15). The chromatographic result is roughly similar to that obtained by the English investigators for beef myoglobin[5]. The main component, which shows a maximum at exactly 578 mμ (Fig. 1), was used for the paper electrophoretic studies and the analysis of the amino-acid composition. No distinct differences were found between the extracts of muscles of adult and fœtal cows during the preparation of the pure myoglobin solutions.

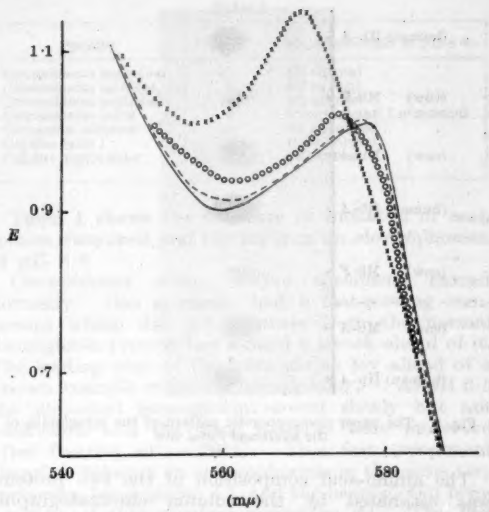


Fig. 1. Spectrophotometric curves of different myoglobin preparations: xxxx, after 70 per cent saturation; oooo, after 80 per cent saturation; – – – –, after 85 per cent saturation; ——, chromatography

The two myoglobin preparations were first studied by paper electrophoresis using a 0·06 *M* veronal buffer, *p*H 8·6. As shown in Fig. 2, the patterns of myoglobin *A* and *F* are similar. Similarly, with a 0·1 *M* phosphate buffer solution, *p*H 6·5, no differences were found. The spectral photometric curves of the two myoglobins in the ultra-violet light did not show appreciable differences in the position of the absorption maxima. The slight flexion in the curve of the fœtal myoglobin, as described by Rossi Fanelli *et al.*[3], could not be confirmed at 290 mμ.

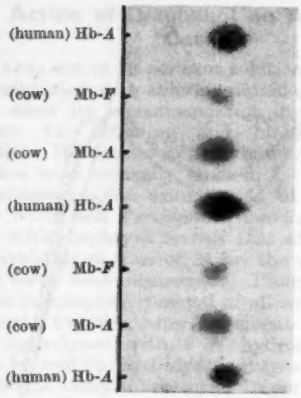


Fig. 2. The paper electrophoretic pattern of the myoglobins of the adult and fœtal cow

The amino-acid composition of the two proteins was estimated by the column chromatographic method of Stein and Moore[7], using 'Amberlite *IR* 120' (*XE* 69). The myoglobins were hydrolysed by refluxing about 50 mgm. of the protein with 200 ml. of 6 *N* hydrochloric acid. The results of the analyses of the amino-acid composition of the 48-hr. hydrolysates of the proteins are given in Table 1. They are also compared with those obtained for the hæmoglobins of the adult and fœtal cow. The amino-acid composition of the adult and fœtal cow hæmoglobin will be discussed elsewhere in detail. All analyses were carried out in triplicate. From Table 1 it is clear that no significant differences are present between the amino-acid compositions of the two myoglobin preparations. The amino-acid composition of the fœtal hæmoglobin, on the contrary, differs in the amounts of serine, alanine, *iso*leucine, histidine and lysine. From our results, however, it is impossible to decide definitely on the existence of a fœtal type of myoglobin in the cow. Such a component may exist, but if it does the chemical composition of this protein must be closely similar to that of the adult myoglobin.

We are much indebted to Drs. Moore and Stein for permission to study their new method of amino-acid analyses before publication, and to Prof. J. H. P. Jonxis for his advice and encouragement during this investigation. This work was supported by a grant from the Dutch Organization of Pure Research (Z.W.O.).

Table 1. Amino-acid Composition of the 48-hr. Hydrolysates of the Myoglobins and the Hæmoglobins of the Adult and Fœtal Cow

(Values are given in gm./100 gm. protein and are the mean of three analyses of different preparations)

Amino-acid	Myoglobin *A*	Myoglobin *F*	Hæmoglobin *A*	Hæmoglobin *F*
Aspartic acid	10·0	10·0	11·9	11·5
Threonine	3·3	3·2	4·8	4·3
Serine	3·1	3·2	5·2	7·1
Glutamic acid	13·9	13·6	7·9	8·5
Proline	2·5	2·3	3·8	4·3
Glycine	5·1	5·0	3·8	4·2
Alanine	8·1	8·7	10·3	9·1
Valine	6·1	6·2	10·4	10·9
Methionine	1·9	1·7	1·4	1·6
*iso*Leucine	3·9	4·0	0	0·7
Leucine	12·8	13·0	15·2	15·6
Tyrosine	2·3	1·9	2·1	2·2
Phenylalanine	5·9	6·2	6·6	6·8
Histidine	11·5	10·9	8·1	7·2
Lysine	15·4	15·8	11·5	9·2
Arginine	2·5	2·5	4·2	4·6
Total	108·3	108·6	107·2	107·8

R. Timmer
H. J. van der Helm
T. H. J. Huisman

Department of Paediatrics,
State University of Groningen,
The Netherlands. April 1.

[1] Theorell, H., "Advances in Enzymology", 7, 265 (1947).
[2] Jonxis, J. H. P., and Wadman, S. K., *Nature*, **169**, 884 (1952). Wadman, S. K., thesis, Groningen (1953).
[3] Rossi-Fanelli, A., Cavallini, D., and de Marco, C., *Arch. Biochem. Biophys.*, **50**, 496 (1954).
[4] Singer, K., Angelopoulos, B., and Ramot, B., *Blood*, **10**, 987 (1955).
[5] Boardman, N. K., and Adair, G. S. A., *Nature*, **177**, 1078 (1956).
[6] de Duve, C., *Acta Chem. Scand.*, **2**, 264 (1948).
[7] Stein, W. H., and Moore, S. (personal communication).

Myoglobins from Sheep Homozygous for Different Hæmoglobin Types

In recent years, the presence of different abnormal hæmoglobins not only in human beings but also in some species of animals has been described. It is still a question whether this genetically controlled deviation is limited to the synthesis of hæmoglobin or whether other abnormal proteins (for example, the related myoglobin) are synthesized at the same time. Singer *et al.*[1] studied this problem in patients with sickle cell anæmia; they used spectroscopic and electrophoretic methods, but failed to demonstrate the presence of an abnormal type of this muscle protein.

Since many kinds of animals are known to possess different types of hæmoglobin, the possibility exists of investigating the myoglobin of animals which are homozygous for one of the different hæmoglobins. Recently, we described[2] some characteristic properties of two different hæmoglobins of the sheep (hæmoglobin I and II). These two proteins differ in electrophoretic and chromatographic behaviour, in solubility, resistance to alkali and amino-acid composition. In this communication we present the results of an investigation concerning possible differences between the myoglobins obtained from sheep which were homozygous for one of these two different hæmoglobin types. Characterization of the two proteins was attempted by electrophoretic and spectroscopic techniques and by the analyses of the amino-acid compositions.

The muscle proteins were prepared as described for cow myoglobin[3]. It was found that during isolation and purification the behaviour of sheep myoglobin was identical with that of cow myoglobin. The paper electrophoretic experiments were carried out with a 0·06-*M* barbital buffer solution, *p*H 8·6, using Whatman 3 *MM* paper. As shown in Fig. 1,

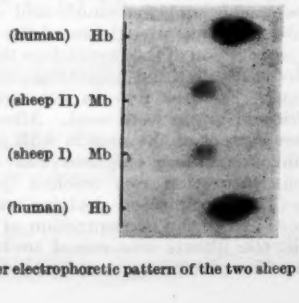


Fig. 1. Paper electrophoretic pattern of the two sheep myoglobins

Table 1. Amino-acid Composition of the Myoglobins and Hæmoglobins of Sheep Homozygous for One of the Two Hæmoglobins. (Values are given in gm./100 gm. protein)

Amino-acid	Myoglobin-I	Myoglobin-II	Hæmoglobin-I	Hæmoglobin-II
Aspartic acid	9·2	9·6	13·5	12·5
Threonine	3·2	2·9	4·45	5·1
Serine	2·9	3·15	4·15	4·85
Glutamic acid	13·35	13·8	7·4	8·1
Proline	1·9	1·7	3·35	3·5
Glycine	5·7	5·4	5·1	3·95
Alanine	8·2	8·0	9·95	8·8
Valine	6·1	6·1	10·85	11·15
Methionine	2·8	2·95	1·8	
*iso*Leucine	4·65	4·7	0	0
Leucine	13·7	14·15	16·1	16·1
Tyrosine	2·25	2·6	2·6	3·05
Phenylalanine	7·9	8·3	7·05	7·6
Histidine	9·4	9·2	8·15	8·2
Lysine	15·5	15·25	8·7	8·5
Arginine	2·0	2·05	4·05	4·2
Total	108·75	109·85	107·2	105·6

no difference could be detected. Also the ultra-violet spectral absorption curves of the two proteins were completely similar. Amino-acid analyses of the 48-hr. hydrolysates of the two myoglobins were carried out, using the column chromatographic method of Stein and Moore[4] with the cation exchanger 'Amberlite *IR* 120' (*XE* 69). The results of duplicate experiments are given in Table 1; they are compared with the values described for the two hæmoglobins of the sheep. From these results it will be clear that in this respect also there are no significant differences between the two myoglobin preparations. The amino-acid analyses of the two hæmoglobins, on the contrary, showed the existence of small but distinct differences in the amounts of aspartic acid, glycine, alanine, glutamic acid, threonine and serine.

Summarizing, it may be concluded that our investigations fail to reveal any difference in the spectroscopic and electrophoretic behaviour and in the amino-acid composition of the myoglobins of sheep with different types of hæmoglobins. Our results do not support the hypothesis that the genetically controlled abnormality of producing more than one type of hæmoglobin in one species of animal is not limited to this protein particularly.

This investigation was supported by a grant from the Dutch Organization for Pure Research (Z.W.O.).

H. J. van der Helm
R. Timmer
T. H. J. Huisman

Department of Paediatrics,
University of Groningen,
The Netherlands. April 1.

[1] Singer, K., Angelopoulos, B., and Ramot, B., *Blood*, **10**, 979 (1955).
[2] van der Helm, H. J., van Vliet, G., and Huisman, T. H. J., *Arch. Biochem. Biophys.* (in the press).
[3] Timmer, R., van der Helm, H. J., and Huisman, T. H. J. (preceding communication).
[4] Moore, S., and Stein, W. H. (private communication).

Abnormal Hæmoglobins in Monkeys

We wish to report the finding of abnormal hæmoglobins in two species of monkeys. The monkeys had been shot in the Uganda Protectorate as part of another investigation and their blood has been subject to paper strip electrophoresis. At first lysed whole blood was used, but later larger specimens were collected and hæmoglobin solutions prepared. Hæmoglobins which behaved on electrophoresis like human *AA* hæmoglobin solutions were taken as the normal reference point.

Table 1

Species	No.	Electrophoresis at *p*H 8·6
Cercopithecus ascanius	37	all normal
Cercopithecus aethiops	3	all normal
Cercopithecus neglectus	6	all normal
Cercopithecus mitis	6	5 normal and 1 abnormal
Cercocebus albigena	16	all abnormal
Colobus badius	2	both normal
Colobus abyssinicus	3	all normal

Table 1 shows the numbers of monkeys of each species examined and the findings on electrophoresis at *p*H 8·6.

Cercopithecus mitis. Five specimens moved normally. One specimen had a fast-moving component which did not separate from the normal hæmoglobin present but formed a streak ahead of it. The leading edge of the hæmoglobin lay ahead of a known example of human hæmoglobin *J* [1]. At *p*H 6·5 the abnormal hæmoglobin moved slowly but not backwards and the same patterns were preserved after freezing at − 20° C. This fast component therefore behaves on electrophoresis in the same way as human hæmoglobin *I* [2], and the hæmoglobin composition of this monkey resembles *AI*. The fast component of this mixture differs from the hæmoglobin *I* described by Rucknagel *et al.*[3] in constituting a larger proportion of the total.

Cercocebus albigena. At *p*H 8·6 all the hæmoglobin specimens from this species moved as a single band

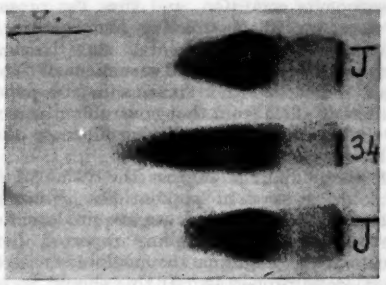


Fig. 1. Electrophoretic patterns of hæmoglobin from *Cercopithecus mitis* with the fast-moving component (34) compared with hæmoglobin *J* at *p*H 8·6

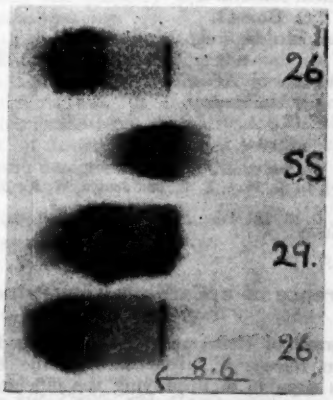


Fig. 2. Electrophoretic patterns of hæmoglobin from *Cercocebus albigena* (29) running behind a normal *Cercopithecus ascanius* (26) and ahead of a hæmoglobin from human sickle cell anæmia (*SS*) at *p*H 8·6

Table 2

Species	No.	Results
Cercocebus albigena	7	trace of A.R.H. in all
Cercopithecus ascanius	9	trace of A.R.H. in 7
Colobus badius	1	trace of A.R.H. present
Colobus abyssinicus	2	trace of A.R.H. in both

slower than normal hæmoglobin but faster than human hæmoglobins *S* or *D*. The bands lay slightly nearer the normal or *A* position than the *S* position. This position corresponds to hæmoglobin *GG* in humans[3]. At *p*H 6·5 no difference could be observed between these and normal hæmoglobin.

At the suggestion of Dr. H. Lehmann some of the specimens were examined for alkali-resistant hæmoglobin (A.R.H.) by Singer's method. The results are shown in Table 2.

The traces of alkali-resistant hæmoglobin present were less than 4·0 per cent and too small to determine accurately. The slow movement of the hæmoglobins from the species of *C. albigena* is not, therefore, explicable on the grounds of small amounts of alkali-resistant hæmoglobin. The ages of the monkeys were not accurately known but none was an infant and some were old adults, so that by analogy with humans in whom alkali-resistant fœtal hæmoglobin has largely disappeared by the age of three months its presence would not be expected in these monkeys.

The presence of two components in the hæmoglobin of one specimen of *Cercopithecus mitis* indicates a heterozygous condition, and thus the presence of more than one allele affecting hæmoglobin in the population. The presence of a slow hæmoglobin, moving as a single band in all specimens of *Cercocebus albigena*, indicates either fixation in the population of a different allele from that controlling hæmoglobin *A*, or the fixation of a modifying allele or alleles at other loci.

Both these findings suggest the value of further hæmoglobin studies in populations of non-human primates. Further studies are required to find out if the abnormal hæmoglobins reported here are identical with those human hæmoglobins with similar electrophoretic properties. If this should be proved, then non-human primates may become valuable for research in human genetics.

G. F. Jacob

Medical Laboratory,
P.O. Box 41,
Kampala, Uganda.

N. C. Tappen

Department of Anatomy,
Emory University,
U.S.A.
April 4.

[1] Raper, A. B., *Brit. Med. J.*, [i, 1235 (1957)].
[2] Rucknagel, D. L., Page, E. B., and Jensen, W. N., *Blood*, **10**, 999 (1955).
[3] Edington, G. M., Lehmann, H., and Schneider, R. G., *Nature*, **175**, 850 (1955).

Occurrence of a Cardio-active Principle in Spleen

The work of Rein[1] and Pinotti[2] showed that the liver can release a substance into the circulation which is capable of improving the efficiency of the heart in a manner which could not be explained solely on hæmodynamic grounds. These two authors believed that the liver material acted by improving the energy metabolism of the heart, leading to greater economy of cardiac work. Later work reported by Rein[3,4] indicated that the stimulus for the release of the active liver principle was cardiac hypoxia, which caused release of a material from the spleen into the blood stream. This material was transported to the liver, where it served as stimulus for the release of the active liver principle. Rein's work has shown that the materials involved in the reaction must be of a hormonal nature. In 1952, Green[5] described an extract from the non-saponifiable components of ox liver which exerted a positive inotropic action on the isolated papillary muscle of the cat. This work has been confirmed here, and an examination has been made of extracts of spleen to determine whether any cardioactive material is present in this organ.

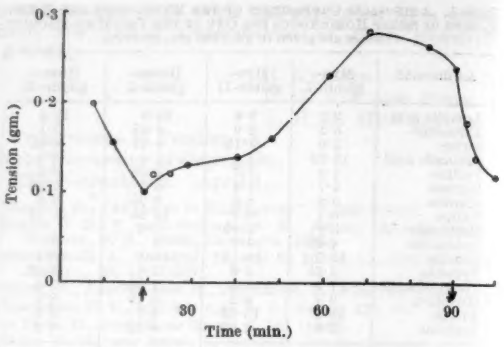


Fig. 1

Freshly removed ox spleen was minced and freeze-dried. Serial extractions of the freeze-dried material were performed in a Soxhlet apparatus using petroleum ether (40°–80° C. fraction), di-ethyl ether, acetone and methanol, all solvents being purified and re-distilled before use. The various fractions were evaporated to dryness over a water-bath and were stored in stoppered vessels at 4° C. For each experiment a weighed quantity of extract was dissolved or suspended in a quantity of physiological medium of identical composition, *p*H and temperature to that bathing the preparation.

Using the isolated papillary muscle of the cat, we were able to demonstrate the absence of positive inotropic activity in the petroleum ether and di-ethyl ether fractions, but the acetone fraction contained a cardio-active material which gave a positive inotropic effect. A typical record for this extract is shown in the graph of Fig. 1. A similar positive inotropic effect was observed on the isolated Langendorff heart of the guinea pig, which showed an increased amplitude of beat, together with a slight increase in rate and coronary flow.

The method of extraction precludes this effect being due to ionic changes since no inorganic salts could appear in this extract. The extract was also free of substances such as histamine and acetyl choline, for when tested on isolated guinea pig ileum no contraction resulted with quantities greater than those required to produce a positive inotropic effect on the heart. Work is at present in hand to produce a purer preparation.

We wish to acknowledge grants in aid of this investigation from the National Health and Medical Research Council, and the Kahn Fund for Medical Research, and to extend our thanks to Mr. J. D.

Mellor, of the Commonwealth Scientific and Industrial Research Organization, for provision of freeze-drying facilities.

L. B. Cobbin
R. H. Thorp

Department of Pharmacology,
University of Sydney.
April 8.

[1] Rein, H., *Klin. Wochr.*, **21**, 873 (1942).
[2] Pinotti, O., *Arch. Fisiol.*, **42**, 170 (1942).
[3] Rein, H., *Naturwiss.*, **36**, 260 (1949).
[4] Rein, H., *Arch. f.d. ges. Phys.*, **253**, 435 (1951).
[5] Green, J. P., *Amer. J. Phys.*, **170**, 330 (1952).

Hydroxyproline and Thermal Stability of Collagen

Gustavson[1] has recently directed attention to the importance of hydroxyproline residues in determining the hydrothermal stability of a collagen. He examined collagen samples from two broad sources, namely, mammalian and teleost connective tissue, and his findings demonstrated a direct relationship between the hydroxyproline content of a collagen and its shrinkage temperature. He considers that hydroxyproline will form interchain hydrogen bonds between its hydroxyl group and the carbonyl oxygen of an adjacent peptide grouping and may also be involved in the formation of ester links between polypeptide chains, thus playing a very important part in determining the stability and general reactivity of a collagen fibre. The evidence for assigning such a function to the hydroxyproline residue has, however, been derived from a study of many animal species. Furthermore, there is a growing body of evidence[2–4] which indicates that the reactivity of a collagen fibre depends on age and it still remains to be established whether variations in the hydroxyproline content can account for the differing degrees of reactivity with age, shown by collagen obtained from a single animal species.

We now wish to report some findings which bear on this question. In a study of the action of collagenase on samples of dermal collagen from sixty individuals, Keech[3] found that fifty of these responded normally to the enzyme, the response being a function of age. Eight samples, however, failed to show any digestion as assessed by the electron microscope, that is, were collagenase-resistant, while two other samples, taking into account their age, reacted excessively. As part of a more detailed investigation into those collagen preparations which show an abnormal response towards collagenase, hydroxyproline content and shrinkage temperature were determined. In all, fourteen samples of the same preparations used in previous work were examined, namely, human abdominal skin from persons of different age, purified by the method of Neuman[5] as shortened by Keech[3]. These collagen samples were classified into groups: group 1, ten showing normal response towards collagenase; group 2, two which were collagenase-resistant; and group 3, two which were hypersensitive towards collagenase.

Hydroxyproline content was determined using the method of Martin and Axelrod[6], to an accuracy of ± 5 per cent. The range of temperature over which the samples shrunk was determined by the microscopic method of Borasky and Nutting[7]. Small fibres were teased from the samples and rehydrated in distilled water for one hour, before mounting in the heating chamber. Heat was applied at a constant rate (2 deg. C./min.) and, so far as possible, fibres of similar size were used. Following Borasky and Nutting, the range of shrinkage was determined by recording both temperatures at which the fibres started to shrink and also the final one at which no further change in dimensions occurred.

Table 1

	No.	Age (years)	Hydroxyproline (gm./100 gm. dry collagen)	Range of shrinkage (° C.)
	1	7	14·3	65–69
	2	9	13·6	64·5–68·5
	3	19	13·7	65–66
	4	23	13·6	65·5–69
Group 1 (control)	5	27	14·2	64–67·5
	6	36	13·6	62–69
	7	42	13·1	65·5–69·5
	8	43	12·5	63–68
	9	57	13·1	70·5–74
	10	89	12·8	62–68
Group 2 (collagenase resistant)	11	18	14·0	72–77
	12	51	12·3	72–79·5
Group 3 (collagenase hypersensitive)	13	20	14·0	60–67
	14	52	12·5	60·5–65

The results are shown in Table 1. The hydroxyproline levels all lie within the range 12·3–14·3 per cent and within the accuracy of the determination these are reasonably constant, though there is a tendency in all three groups for the values to decrease with age. Until more accurate methods of determination become available, all that can be said, therefore, is that the hydroxyproline content of collagen preparations from one animal species does not vary much with age. On the other hand, the temperature-ranges of shrinkage shown by the three groups are quite distinct. With the exception of sample 9, the collagens in the control group (group 1) shrank over the range 62–69·5° C., the collagenase-resistant samples in group 2 over 72–79·5° C., while those in group 3, which are hypersensitive towards collagenase, shrank over a lower temperature-range, namely, 60–67° C. Furthermore, even with samples of similar age, although the hydroxyproline levels lie fairly close together, the temperature-ranges of shrinkage are again quite distinct. It seems probable, therefore, that the views of Gustavson may require amending since the thermal shrinkage of collagens from one animal species may be independent of the hydroxyproline content and that other factors, which depend on age, may be more important in determining the stability and general reactivity of such protein systems.

We wish to thank Dr. M. K. Keech of the Department of Medicine for supplying the samples of human dermal collagen, Mr. J. W. Czerkawski of the Nuffield Gerontological Unit for assistance in the hydroxyproline determinations, and Mr. A. Gill of the Department of Leather Industries for the shrinkage-temperature determinations.

D. A. Hall

Nuffield Gerontological Research Unit,
Department of Medicine,

R. Reed

Department of Leather Industries,
University of Leeds. April 6.

[1] Gustavson, K. H., *Nature*, **175**, 70 (1955).
[2] Banfield, W. G., *Anat. Rec.*, **114**, 157 (1952).
[3] Keech, M. K., *Ann. Rheum. Dis.*, **14**, 19 (1955).
[4] Verzar, F., *Helv. Physiol. Acta*, **14**, 207 (1956).
[5] Neuman, R. E., *Arch. Biochem.*, **24**, 289 (1949).
[6] Martin, C. J., and Axelrod, A. E., *Proc. Soc. Exp. Biol. N.Y.*, **83**, 461 (1953).
[7] Borasky, R., and Nutting, G. C., *J. Amer. Leather Chem. Assoc.*, **44**, 830 (1949).

Catechol Compounds in Rat Tissues and in Brains of Different Animals

Estimates, made by the ethylenediamine method, of adrenaline and noradrenaline concentrations in rat tissues have already been reported[1]; they varied seasonally[2]. Experiments have now been carried out to investigate the occurrence of other catechol compounds. Some material, probably hydroxytyramine, has consistently been found in rat liver and spleen, and particularly in brain; other brains have been analysed.

Tissues were extracted with acid methanol as before[1]; after treatment with alumina they were passed, at *p*H 6·5, over columns of 'Amberlite *IRC*-50' cation exchange resin, to separate acidic and neutral material, if present, from basic compounds; the latter are retained by the resin and eluted. Noradrenaline (N) and adrenaline (A) were estimated in the eluate as fluorescent trihydroxyindole derivatives[3]: the eluates were also condensed with ethylenediamine dihydrochloride (ED) and readings taken with a yellow filter[4]; when part of this ethylenediamine dihydrochloride-fluorescence was not accounted for by noradrenaline and adrenaline it was designated *X*; concentrations of *X* have been calculated in terms of hydroxytyramine (H) with which it may be identical. The condensation product of hydroxytyramine with ethylenediamine dihydrochloride has about one-third of the fluorescence intensity of that of adrenaline.

If present, 3 : 4-dihydroxyphenylalanine (dopa) and 3 : 4-dihydroxyphenylacetic acid (dopac) would appear in the resin filtrate; 3:4-dihydroxyphenylalanine forms a fluorescent indole derivative; both form fluorescent compounds with ethylenediamine dihydrochloride; these, unlike those formed by noradrenaline, adrenaline and hydroxytyramine, are more soluble in saturated aqueous solutions of sodium chloride than in *iso*butanol; the aqueous solutions were extracted with *iso*butanol as usual, but both phases were read fluorimetrically. 3 : 4-Dihydroxyphenylalanine and basic compounds can be separated from acidic catechol compounds by using 'Zeokarb 225' resin.

X was present in varying concentration in extracts of whole brains from rats analysed at different times of the year; it had the R_F value of hydroxytyramine[5]; it was present also in whole brains from guinea pigs, rabbits and chicks. Neutral and acid catechol compounds, if present, were in amounts too small to be identified. By contrast, preliminary analysis of a normal human brain extracted in 0·05 *N* hydrochloric acid 30 hr. after death showed that noradrenaline, adrenaline and *X* were responsible for only 40 per cent of the ethylenediamine dihydrochloride-fluorescence, and that 3 : 4-dihydroxyphenylalanine was probably present. The presence of the latter was confirmed by paper electrophoresis[6] of an eluate from 'Zeokarb 225' resin, and by paper chromatography[5] of a filtrate from *IRC*-50 resin. The chromatogram also showed a spot, less intense than that due to 3 : 4-dihydroxyphenylalanine, with an R_F value slightly higher than 3 : 4-dihydroxyphenylacetic acid, and probably due to some other catechol acid; its concentration has been calculated in terms of 3 : 4-dihydroxyphenylacetic acid. Paper chromatograms[5] of the eluate from *IRC*-50 resin gave quantitative recoveries (92–98 per cent) of noradrenaline, adrenaline and *X*; *X* had the R_F value of hydroxytyramine.

Table 1. Concentrations of Catechol Compounds in Whole Brains of Different Animals

Animal	Total ED-fluorescence in terms of A (mμgm. A/gm. brain)	N	A	*X*	Dopa	Dopac
		(mμgm./gm. brain)				
Man	110	21·2	4·38	94·2	200	90
Rabbit	229	126	20·2	288	—	—
	183	110	22·1	175	—	—
Guinea pig	173	106	37·6	177	—	—
	299	110	43·3	410	—	—
Rat (mean ± standard error)*	447 ± 65·1	219 ± 15·2	69·3 ± 6·95	642 ± 119	—	—
Chick	151	66·3	36·8	130	—	—
	142	50·8	30·2	185	—	—
Frog	1,175	—	—	—	—	—
	1,140	—	—	—	—	—

* 5 estimations.

Concentrations of catechol compounds found in brains of different animals analysed at the same times showed considerable differences and are shown in Table 1: the estimates have not been corrected for oxidation of noradrenaline at *p*H 3·5 (trihydroxyindole method)[3]. *X*, from its higher concentration in rat and rabbit compared with human brain, does not appear to be identical with encephalin[7], especially since it is stated that extraction of encephalin is slight in alcoholic compared with aqueous solution[8]; in the present experiments alcoholic solution was used for all except human brain. However, the estimates of fluorescence in eluates and filtrates of the human brain treated with *IRC*-50 resin showed that losses had occurred, perhaps in the filtrates but more probably through retention of some substance by the resin. Frog brains are included in Table 1; extracts were treated with alumina only and the ethylenediamine dihydrochloride-fluorescence (yellow filter) calculated in terms of adrenaline.

Other rat tissues, heart, kidneys, liver, spleen and diaphragm, have also been analysed; as in brain, most or all of the ethylenediamine dihydrochloride fluorescence has been due to noradrenaline, adrenaline and *X*. *X* has been present in varying concentrations in liver and spleen, always forming a smaller proportion of the catecholamines than in brain; it has not always been found in heart, kidneys and diaphragm. Its concentration, as well as those of noradrenaline and adrenaline, appears to vary seasonally; the course of these variations is still being investigated. There is evidence that they depend on the adrenal cortex: the ethylenediamine dihydrochloride-fluorescence in hearts of rats bilaterally adrenalectomized 6–10 weeks previously was less than, or greater than, that in hearts of control rats analysed simultaneously, according as the level in normal rats had increased or decreased since the time of operation. The medulla does not seem to be responsible: adrenal demedullation produced a slight increase of the ethylenediamine dihydrochloride-fluorescence in hearts, and a considerable decrease in kidneys, as judged by simultaneous analysis, in November, of intact and demedullated rats; comparison of the latter with intact rats analysed at the time of operation (September) showed large increases of catechol compounds in both tissues since operation.

I am grateful to Dr. H. Weil-Malherbe for advice, to Dr. D. C. Caldwell for supplying the human brain,

and to Messrs. Poultry Packers (Essex), Ltd., for fresh chicks' heads. The work was supported by a grant from the Medical Research Council.

K. A. MONTAGU

Research Department,
Runwell Hospital,
Wickford, Essex. April 17.

[1] Montagu, K. A., *Biochem. J.*, **63**, 559 (1956).
[2] Montagu, K. A., *Nature*, **178**, 417 (1956).
[3] Euler, U. S. von, and Floding, I., *Acta Physiol. Scand.*, **33**, Supp. 118, 45 (1955).
[4] Weil-Malherbe, H., and Bone, A. D., *Biochem. J.*, **51**, 311 (1952).
[5] Partridge, S. M., *Biochem. J.*, **42**, 238 (1948).
[6] Weil-Malherbe, H., *Lancet*, ii, 282 (1956).
[7] Raab, W., and Gigee, W., *Proc. Soc. Exp. Biol. Med.*, **76**, 97 (1951).
[8] Raab, W., *Amer. J. Physiol.*, **152**, 324 (1948).

Conversion of Pyruvic Acid to Alanine in the Silkworm Larva

As reported earlier[1], we tried to isolate keto acids of importance physiologically in the body fluid and the silk-glands of the silkworm larvæ and found that there were present glyoxylic, α-keto-glutaric, oxalacetic and acetoacetic acids. Pyruvic acid, which is found usually in mammals, was not recognized in the silkworms. The present work was carried out to determine whether, although pyruvic acid is not found in the body fluid and the silk-glands, metabolism involving pyruvic acid takes place in the silkworm.

The silk-glands, the alimentary canals, also the muscle and the fat tissues obtained from five larvæ (Si 110 × Nichi 122) on the sixth day of the fifth instar were washed with cold water and suspended in *M*/15 phosphate buffer, *p*H 7·4, and homogenized in homogenizer and made up to 5 ml. Each sample was placed for 5 hr. at 0° and then kept at − 18° overnight. The insoluble proteins obtained by thawing the ice at room temperature were discarded, and the supernatant solution was used as the enzyme solution. To 1 ml. portions of each enzyme solution were added 0·5 ml. of 0·1 *M* L-glutamic acid, 0·5 ml. of 0·1 *M* sodium pyruvate and 0·1 ml. of *M*/15 phosphate buffer, *p*H 7·4, containing 0·1 μc. of sodium pyruvate-2-^{14}C, and this mixture was incubated for 60 min. at 38°. The solutions of L-glutamic acid and sodium pyruvate were made in *M*/15 phosphate buffer, *p*H 7·4, immediately prior to use. The reaction was stopped by adding 200 mgm. of trichloracetic acid. This filtrate was analysed by means of paper chromatography, using *n*-butanol/acetic acid saturated with water (*n*-butanol, 95/acetic acid, 5) as a solvent. Two spots were revealed on a strip which was sprayed with ninhydrin in the usual way: one of them (R_F 0·42) was alanine and the other (R_F 0·16) was glutamic acid remaining in the reaction mixture. The strip was scanned for radioactivity by an *SC*-16 windowless gas-flow counter. As shown in Fig. 1, higher radioactivity was recognized at the position of the alanine. A lower radioactivity was also recognized at the position of R_F 0·14, at nearly the same position as glutamic acid, but this proved, by comparison with the behaviour of pure sodium pyruvate-2-^{14}C on a chromatogram, to be due to the appearance of isotopic sodium pyruvate remaining in the reaction mixture on the chromatogram. Radioactivities of the alanine spot on the chromatograms obtained from three tissues of the silkworm are presented in Table 1. The results seem to suggest that the synthesis of alanine from pyruvic acid with glutamic acid takes place in the silk-glands, the alimentary canal, and muscle and fat tissues. Recently the occurrence of the transamination reaction in the silkworm was also indicated by Bheemeswar *et al.*[2] and Koide *et al.*[3].

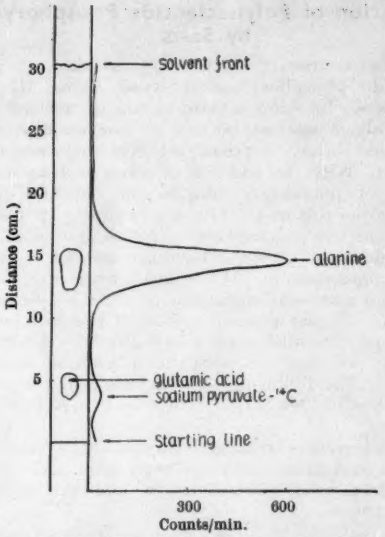


Fig. 1. Radioactivity of chromatogram of reaction mixture *n*-butanol/acetic acid saturated with water run from the starting line

Table 1. RADIOACTIVITIES OF THE ALANINE SPOT ON THE CHROMATOGRAMS

Tissues	Counts/min. of alanine spot formed
Posterior division of silk-gland	420
Alimentary canal	330
Muscles and fat tissues	273

As glutamic acid and aspartic acid are the main constituent amino-acids of the proteins of the mulberry leaves, this reaction, which produces alanine from pyruvic acid with glutamic acid, seems to be of special importance in the synthesis of the alanine (25 per cent) of the silk, as well as in the formation of alanine by β-decarboxylase[4] from aspartic acid in the silkworm. Florkin *et al.*[5] demonstrated, using radioactive phenylalanine-1-^{14}C, that the carboxyl carbon of phenylalanine was not utilized for the synthesis of alanine of the silk by the silkworm. Recently I ascertained that the carbon-14 of the sodium pyruvate-2-^{14}C given to silkworms appeared in the alanine isolated from the cocoon fibres produced by these silkworms, and glutamic acid and aspartic acid played the most important part at the synthesis of alanine from pyruvic acid with amino-acids[6].

T. FUKUDA

Sericultural Experiment Station,
Tokyo.
March 27.

[1] Fukuda, T., Hayashi, T., and Matuda, M., *J. Jap. Biochem. Soc.*, **27**, 147 (1955).
[2] Bheemeswar, B., and Sreeninasaya, M., *Current Sci.*, **21**, 253 (1952); *J. Sci. Indust. Res., India*, **13**, B, 108 (1954).
[3] Koide, F., Nagayama, H., and Shimura, K., *J. Agric. Chem. Soc. Japan*, **29**, 987 (1955).
[4] Bheemeswar, B., *Nature*, **176**, 555 (1955).
[5] Bricteux-Gregoire, S., Verly, W. G., and Florkin, M., *Nature*, **177**, 1237 (1956).
[6] Fukuda, T., *J. Biochem. (Japan)* (in the press).

Activation of Polynucleotide Phosphorylase by Salts

In the course of purification studies of polynucleotide phosphorylase (polyase) from *M. lysodeikticus* we have on several occasions noticed that, after dialysis against buffers at low ionic strength or distilled water, considerable loss of enzyme activity occurred. With the addition of a salt such as sodium acetate or potassium chloride the activity of the enzyme was restored. The activation by potassium chloride of the polymerization of adenylic acid from adenosine diphosphate, determined by rate of release of orthophosphate at *p*H 9·5, is shown in Fig. 1. The optimum salt concentration is 0·2 *M* potassium chloride. Higher concentrations of the salt become inhibitory. Parallel studies based on the determination of polymer concentrations yielded identical results[1]. The following salts activate in the order: $KCl > NaCl > Na_2SO_4 = HCOONa > CH_3COONa >$ LiCl.

The degree of activation at any particular normality and the maximum extent of activation is dependent on both the cation and anion and the substrate concentration.

Table 1

Potassium chloride concentration	0·02 *M*	0·04 *M*	0·1 *M*	0·2 *M*	0·6 *M*
V^*_m (rel.)	1·55	1·39	1·46	1·38	1·85
$K^*_m \times 10^{-4}$	12·6 *M*	7·10 *M*	5·63 *M*	3·24 *M*	13·3 *M*

The effect of varying substrate concentrations on the rate of polymerization in the absence and in the presence of 0·2 *M* potassium chloride at *p*H 9·5 is illustrated in Fig. 2. The rate–substrate curve at low concentration of adenosine diphosphate is non-linear and has a slope greater than that of the control without potassium chloride. At high substrate concentrations the rate–substrate curve is linear, and has a slope equal to that of the control and independent of the concentration of potassium chloride. The non-linear portion of the curve fits the Michaelis–Menten equation. Table 1 lists the K^*_m and V^*_m values calculated at various concentrations

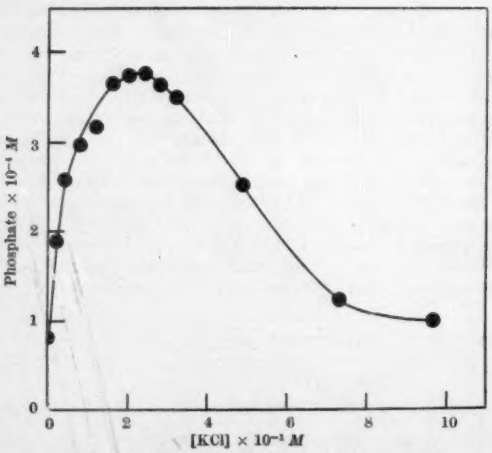


Fig. 1. Rate of orthophosphate liberation as a function of concentration of potassium chloride. Reaction mixture consisted of 0·5 ml. 0·2 per cent adenosine diphosphate, 0·5 ml. enzyme, 0·5 ml. 2 × 10^{-3} *M* magnesium chloride, 0·2 ml. 0·5 *M* tris buffer, *p*H 9·5, and 0·8 ml. of potassium chloride solution. Temperature 37° C., incubation 20 min. Rate is recorded as increase in orthophosphate concentration

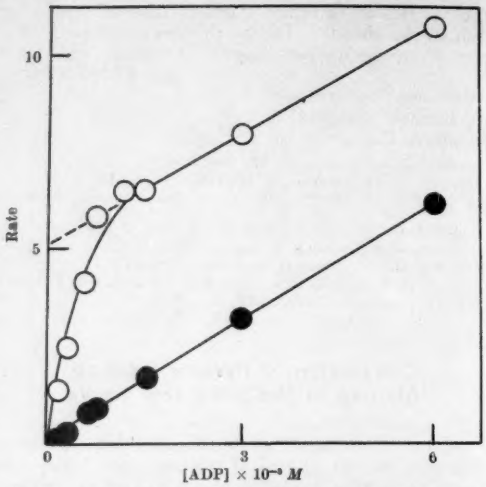


Fig. 2. Rate of orthophosphate liberation as a function of concentration of adenosine diphosphate with 0·2 *M* potassium chloride ○; and without addition of potassium chloride ●. Reaction mixture consisted of 0·5 ml. enzyme, 0·5 ml. 2 × 10^{-3} *M* magnesium chloride, 0·2 ml. 0·5 *M* tris buffer *p*H 9·5, 0·5 ml. water or 1·0 *N* potassium chloride and 0·8 ml. adenosine diphosphate solutions. Temperature 37° C., incubation 10 min. Rate is recorded in arbitrary units

of potassium chloride. With the exception of the experiment in 0·6 *M* potassium chloride, the maximum velocity, V^*_m, is unaffected by salt concentrations. However, the apparent Michaelis constant, K^*_m, changes with salt concentration. Indeed, the activation curve given in Fig. 1 parallels the change in $1/K^*_m$ with concentrations of potassium chloride. The values of K^*_m are strongly dependent upon the extent of removal of the salts in the enzyme preparation, particularly ammonium sulphate. The polymerization of other polymers (polycytidylic and polyuridylic acids) is also activated to a comparable degree, depending on the experimental conditions.

The presence of high salt concentration alters the degree of activation by magnesium[2]. The value of V^*_m increases with concentration of magnesium but, depending on the concentration of magnesium, K^*_m/V^*_m, does not vary appreciably. The linear portions of the rate-substrate curves shown in Fig. 1 are affected equally by magnesium. The curvature of the non-linear portion is decreased.

From these preliminary studies, we conclude that ionic strength influences the binding of the substrate by the enzyme and probably by the enzyme–polymer complexes. The marked effect of magnesium on V^*_m and on the linear portion of the rate–substrate curve suggests that magnesium may play a part in the events following the binding of the substrate to the enzyme or to the enzyme–polymer complexes. However, it is also possible that magnesium itself becomes limiting with increasing salt and substrate concentrations.

The marked sensitivity of polyase to changes of salt concentration, particularly at low salt concentrations, must be taken into consideration in measurements of activities of the enzyme in various tissues and extracts, and in measurements of the relative activities of such preparations toward specific nucleoside 5′-diphosphates.

This research has been supported by the Louise C. Bowles Research Fund and by a grant from Miles

Laboratories, Inc., Elkhart, Indiana. I wish to thank Miss G. Armilei for her assistance in these studies.

ROLAND F. BEERS, JUN.
Robert W. Johnson Laboratory,
Bowles Research Fund,
Children's Hospital School, Inc.,
Baltimore 11, Maryland.
April 8.

[1] Beers, jun., R. F., *Nature*, **177**, 790 (1956).
[2] Beers, jun., R. F. *Biochem. J.*, [**68**, 686 (1957)].

Anthocyanidins of *Lochnera rosea*

IN a survey of the anthocyanin flower pigments of plants growing in Trinidad[1], it was found that *Lochnera* (*Vinca*) *rosea* (Apocynaceae) contained an anthocyanin the aglycone of which was not identified. The fresh petals gave on chromatography a major glycosidic component of R_F 0·29 together with traces of two others R_F 0·23, 0·18 in the *n*-butanol/acetic acid/water (40 : 10 : 50) solvent used.

The pigments have now been further investigated. After acid hydrolysis a main pigment was found together with traces of two others. The two minor anthocyanidins were shown by chromatography to be petunidin and malvidin and to be derived from the two minor glycosidic components.

The major anthocyanidin was isolated as follows: fresh flowers (800 gm.) were extracted with 0·1 *N* hydrochloric acid (1·5 l.). The extract was made 2 *N* with hydrochloric acid and boiled for 15 min. After cooling the anthocyanidins were extracted with *n*-butanol (500 ml., then 250 ml.). The combined butanol extract was mixed with water (250 ml.) and light petroleum (2·5 l.) and the bottom layer added to a column of cellulose powder (40 × 3·7 cm.). The anthocyanidins were adsorbed on the top 5 cm. and were developed with *n*-butanol/2 *N* hydrochloric acid (top layer). The anthocyanidins and brown materials separated as discrete bands. This is a general and useful method of isolating anthocyanidins in quantity from crude extracts of flowers.

When the main anthocyanidin band had moved three-quarters of the way down, the column was sucked dry, extruded, and the band cut out. The pigment was extracted with methanol, the solution concentrated *in vacuo* to small volume and diluted with light petroleum. The precipitated pigment was dried *in vacuo*, dissolved in ethanol, and dry hydrochloric acid was passed in a 10 per cent concentration. On standing at 0° C. small regular cubic prisms (56 mgm.) of the main anthocyanidin separated. Found, after repeated recrystallization, C, 56·8; H, 4·7; OCH_3, 23·5: $C_{15}H_{17}O_7Cl$ requires C, 56·8; H, 4·5; OCH_3, 24·4 per cent.

From colour properties[2] the substance obviously belongs to the delphinidin series, and from analysis it is a trimethyl delphinidin. It could not be separated from added hirsutidin on paper chromatography in several solvents (R_F in the Forestal[3] solvent 0·73–0·74). Bearing in mind the possibility of methylation in the 5 instead of the 7 position, as in hirsutidin, the anthocyanidin is provisionally identified as hirsutidin, known previously only in Primulaceae[4].

Three anthoxanthins also occur in the flowers: one has been identified certainly as kaempferol, and a second provisionally as quercetin; the third has not yet been identified. *Lochnera* thus joins the list of plants bearing unrelated anthocyanidins and flavonols in the flowers. Genetical investigations of flower colour are in progress.

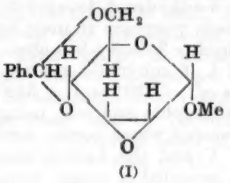
We are indebted to Dr. E. C. Bate-Smith for supplying us with a sample of hirsutidin for comparison.

W. G. C. FORSYTH
Colonial Microbiological Research Institute,
Port of Spain,
Trinidad, British West Indies.
N. W. SIMMONDS
Regional Research Centre,
Imperial College of Tropical Agriculture,
St. Augustine,
Trinidad, British West Indies.
April 5.

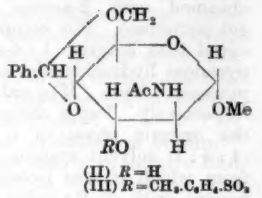
[1] Forsyth, W. G. C., and Simmonds, N. W., *Proc. Roy. Soc.*, B, **142**, 549 (1954).
[2] Robertson A., and Robinson, R., *Biochem. J.*, **23**, 35 (1929).
[3] Bate-Smith, E. C., *Biochem. J.*, **58**, 122 (1954).
[4] Karrer, P., and Widmer, R., *Helv. Chim. Acta*, **10**, 758 (1927).

Characterization of 2-Amino-2-Deoxy-D-Altrose

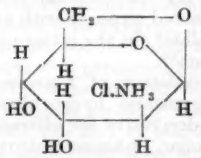
THE action of methanolic ammonia on methyl 2 : 3-anhydro 4 : 6-*O*-benzylidene-α-D-allopyranoside (I) followed by acetylation (pyridine – acetic anhydride) of the isolated amino-compounds yielded, as the major product (45·7 per cent), after recrystallization from aqueous-methanol, methyl 2-acetamido 4 : 6-*O*-benzylidene 2-deoxy-α-D-altropyranoside (II), melting point 188–189°, $[M]_D$ + 218° (acetone). (Found: C, 55·6, 55·8; H, 6·8, 6·7; N, 4·1. $C_{16}H_{21}O_6N.H_2O$ requires C, 56·3; H, 6·7; N, 4·1 per cent).



(I)



(II) R = H
(III) R = $CH_3.C_6H_4.SO_2$



(V)

The structure of (II) was indicated by the following observations.

(*a*) Elemental analysis.

(*b*) The infra-red absorption spectrum, in which the strong absorption at 1,725–1,749 cm.$^{-1}$, characteristic of the *O*-acetyl carbonyl group[1], was absent; but strong absorption at 1,651 cm.$^{-1}$ (*N*-acetyl carbonyl[1]) was present. Methyl 3-acetamido 2-*O*-acetyl 4 : 6-*O*-benzylidene 3-deoxy-α-D-glucopyranoside, the well-studied[2] minor product of the above reaction, showed strong absorption at 1,726 cm.$^{-1}$ and 1,634 cm.$^{-1}$.

(*c*) With excess toluene-*p*-sulphonyl chloride in pyridine, II gave a mono-*O*-toluene-*p*-sulphonate (III), melting point 174° (decomp.), $[M]_D$ + 296° (acetone). (Found: C, 58·0; H, 5·6; N, 3·0; S, 7·2. $C_{23}H_{27}O_8NS$ requires C, 57·9; H, 5·7; N, 2·9; S, 6·7 per cent).

(*d*) Graded acidic hydrolysis[3] of II removed the benzylidene residue and afforded amorphous methyl

2-acetamido 2-deoxy-α-D-altropyranoside (IV), $[M]_D$ +94° (water), which rapidly consumed 1 mol. of periodate without the formation of formaldehyde or acidic products. (The low optical rotation and rapid periodate oxidation of IV suggest conformational instability[4] of the glycoside.) Thus the acetamido group must be located at $C_{(2)}$ in IV and, assuming normal cleavage[5] of the epoxide ring (that is, to give two axial substituents) in the reaction of I with methanolic ammonia, then II, III and IV must have the D-altrose configuration.

The absence of an *O*-acetyl group in II is surprising; further, Peat and Wiggins[2] reported methyl 2-acetamido 3-*O*-acetyl 4 : 6-*O*-benzylidene 2-deoxy-α-D-altropyranoside, melting point 184°, $[M]_D$ + 179° ($CHCl_3$), to be the major product (54·8 per cent) of the same reaction although full experimental details were not given. Re-investigation of the product isolated by these authors confirmed its identity, since it showed strong absorption at 1,729 cm.$^{-1}$ (*O*-acetyl) and 1,624 cm.$^{-1}$ (*N*-acetyl) in the infra-red, and on Zemplén deacetylation it was converted into II.

Total acidic hydrolysis of II gave crystalline 2-amino 1 : 6-anhydro 2-deoxy-β-D-altrose hydrochloride (V), which had an indefinite melting point, $[M]_D$ − 315° (water). (Found: C, 35·8; H, 6·0. $C_6H_{11}O_4$ N.HCl requires C, 36·4; H, 6·1 per cent.)

Substance V did not reduce Fehling's solution (although the hydrolysate from which it was isolated gave a positive reaction suggesting the presence of the free amino-sugar) and consumed 2 moles of periodate (cf. the results of Van Tamelen *et al.*[6], obtained with 2-amino 1 : 6-anhydro-2-deoxy-β-D-gulopyranose). For comparison purposes it may be noted that 3-amino 1 : 6-anhydro 3-deoxy-β-D-altropyranose hydrochloride[7] and 1 : 6-anhydro-β-D-altropyranose[8] have $[M]_D$ values of − 339° and − 348° respectively. Paper chromatographic analysis, using the organic phase of a butanol/water/acetic acid (4 : 5 : 1) solvent system, of V and the hydrolysate from which it was isolated revealed a single component, with an R_F value similar to that of D-glucosamine, which reacted strongly with ninhydrin, aniline hydrogen phthalate[9] (in the latter case) and ammoniacal silver nitrate[10].

The ease of isolation of 2-amino-1 : 6-anhydro-2-deoxy-β-D-altropyranose hydrochloride recommends it as a suitable derivative for characterization of the parent amino-sugar, 2-amino-2-deoxy-D-altrose.

We are indebted to Dr. D. H. Whiffen for the infra-red measurements. One of us (S. V. V.) thanks the Norwegian Pulp and Paper Research Institute for a grant.

A. B. Foster
M. Stacey
S. V. Vardheim

Chemistry Department,
The University,
Edgbaston,
Birmingham 15. April 2.

[1] Barker, Bourne and Whiffen, "Methods of Biochemical Analysis", **3**, 213 (1956).
[2] Peat and Wiggins, *J. Chem. Soc.*, 1810 (1938).
[3] Robertson and Whitehead, *J. Chem. Soc.*, 319 (1940).
[4] Mills, "Advances in Carbohydrate Chem.", **10**, 1 (1955).
[5] Overend and Vaughan, *Chem. and Indust.*, 995 (1955).
[6] van Tamelen, Dyer, Carter, Pierce and Daniels, *J. Amer. Chem. Soc.*, **78**, 4817 (1956).
[7] Wiggins, *J. Chem. Soc.*, 18 (1947).
[8] Richtmyer and Hudson, *J. Amer. Chem. Soc.*, **61**, 214 (1939).
[9] Partridge, *Nature* **164**, 443 (1949).
[10] Hough, *Nature*, **165**, 400 (1950).

Metamict Tantalite from Western Australia

Thirty-four years ago, Bowley[1] recorded an analysis of a manganese-bearing tantalum–niobium oxide mineral that had been collected by Mr. R. C. Black at Yinnietharra, Western Australia. In his report, Bowley stated that Simpson was of the opinion that this mineral belonged to either the orthorhombic columbite–tantalite series or to the tapiolite–mossite group of tetragonal minerals, and with some element of doubt the mineral was tentatively identified as manganomossite.

Palache, Berman and Frondel[2] included this mineral in their treatment of the mineralogy of the tapiolite–mossite series, but clearly directed attention to the fact that the true status of the mineral is in doubt.

Type material, very kindly made available to me by Mr. J. C. Hood, director of the Government Chemical Laboratories, Perth, Western Australia, has now been studied. Autoradiographs of polished fragments exhibit weak but uniform radioactivity, and there are no indications of either inclusions, or zonary distribution of radioactive material as reported by Heinrich and Giardini[3] for columbite from an unspecified locality in Canada.

X-ray diffraction patterns of single particles, 0·2 mm. in diameter, exhibit a few reflexions that are considerably streaked out along arcs, whereas the powder patterns exhibit about thirteen lines, all of which are exceedingly faint. If the mineral is heated in a silica tube *in vacuo* at 1,200° C. for 1 hr., the resultant material yields a fine X-ray diffraction pattern that is in conformity with that obtained from a member of the columbite–tantalite series; the strongest lines yielded by the heated material correspond in a general way with those found in films obtained when the unheated material is employed.

This evidence suggests that the Yinnietharra mineral is metamict tantalite and not a member of the tapiolite–mossite series; accordingly, this would appear to be the first record of a metamict member of the columbite–tantalite series.

A more detailed account of the mineralogy of this Western Australia mineral is to be given elsewhere.

C. Osborne Hutton

School of Mineral Sciences,
Stanford University,
Stanford, California.
April 5.

[1] Bowley, H., Ann. Rep. Dept. Mines, W. Australia (for 1922), Div. VII, Sect. 2, 120 (1923).
[2] Palache, C., Berman, H., and Frondel, C., "Dana's System of Mineralogy", 7th edit., 1, esp. p. 776 (John Wiley and Sons, Inc., New York; 1946).
[3] Heinrich, E. Wm., and Giardini, A. A., *Geol. Soc. Amer. Bull.*, **67**, 12, 2, 1704 (1956).

Dependence on Oxygen and Temperature of the Sensitivity of Broad Bean Roots to γ-Radiation

Mottram[1] claimed that the effect of ionizing radiation on the growth of bean roots was greater in the presence of oxygen or in the cold (~ 0° C.). Since then the oxygen effect has been confirmed by Read[2] and shown in a wide variety of materials. No comparable generalization has been established, however, for temperature. Giles, Beatty and Riley[3], investigating chromosome structural changes in

Tradescantia, have stated that radiosensitivity is affected by temperature differently under conditions of aerobic and anaerobic irradiation.

I have attempted to re-examine the problem, using the reduction in the rate of elongation of the primary root of the broad bean, *Vicia faba* (Sutton's Prolific Longpod), as the index of radiosensitivity. All the radiation exposures were carried out in times not exceeding about 20 min., over a range in which the effects depend only on total dose and not on exposure time. The total growth in 10 days after irradiation is approximately linearly related to the logarithm of the radiation-dose of cobalt-60 gamma-rays. The various modifying treatments give regression lines of the same slope, and from the horizontal separation, an estimate of relative potency of a pair of treatments may be obtained, with fiducial limits at the chosen level of significance[4]. All the results are expressed in terms of such ratios of radiosensitivity, followed in brackets by fiducial limits at the 5 per cent level of significance.

Temperature effect. Under conditions of air saturation, radiosensitivity at 1–2° C. is 1·16 (1·29, 1·05) times that at 19–20° C. The amounts of dissolved oxygen at these two temperatures are, reduced to standard temperature and pressure, 10 cm.^{3} and 6·4 cm.^{3} oxygen/litre, respectively. With equal oxygen concentrations (10 cm.^{3}/litre) the ratio of radiosensitivities would be 0·98 (1·10, 0·89). Under anaerobic conditions the ratio is 1·22 (1·32, 1·12). The effect of temperature on sensitivity over this range is thus small, and is not very different for aerobic and anaerobic irradiations.

Oxygen effect. The foregoing data may also be expressed in terms of the aerobic (10 cm.^{3} oxygen/litre)/anaerobic radiosensitivity factor at the two temperatures, namely, 2·80 (3·05, 2·56) at 19–20° C., and 2·42 (2·59, 2·26) at 1–2° C. The similarity of the oxygen effect under two conditions so different as regards metabolism would seem to imply that the mechanism of this effect does not involve metabolic processes primarily.

Bean seedlings may be kept at a temperature of 1–2° C. for considerable periods (weeks) and after restoration to 19° C. they grow at practically the normal rate. Seedlings which are irradiated and then kept at 1–2° C. and later restored to 19° C. show a reduced growth-rate not very different from the normal radiation effect. The radiation injury thus remains latent but undiminished while in the cold (cf. the observations on frogs by Patt[5]). It is of interest to see whether this latent injury can be modified by oxygen; at ordinary temperatures, the enhancing effect of oxygen on radiosensitivity is completed during irradiation.

(1) Seedlings were irradiated at 1–2° C., with saturation aeration, and then oxygen was removed while they were still in the cold, and the temperature was then brought up to 19° C. in about 20 min. while still under anaerobic conditions; other seedlings had full aeration during and after irradiation. The enhancing effect of the oxygen after irradiation was only 1·05 (1·20, 0·92).

(2) Seedlings were irradiated at 1–2° C., with no oxygen present, and then oxygen was added (saturation aeration) while they were still in the cold, and the temperature was brought up to 19° C. in about 20 min.; other seedlings were kept without oxygen during and after irradiation, until the temperature had reached 19° C. The enhancing effect of the oxygen after irradiation was only 1·01 (1·18, 0·86).

Thus the latent injury both with aerobic and anaerobic irradiation is not influenced by oxygen after the irradiation. If oxygen develops direct radiation injury, as suggested by Alper[6], it must act very quickly after irradiation of a target, even in the cold. In any event, it seems that the effect of oxygen on radiosensitivity is not related directly to metabolic processes.

G. J. Neary

Medical Research Council
Radiobiological Research Unit,
Atomic Energy Research Establishment,
Harwell.
April 5.

[1] Mottram, J. C., *Brit. J. Radiol.*, **8**, 32 (1935).
[2] Read, J., Rep. Brit. Emp. Cancer Campaign, **24**, 88 (1947).
[3] Giles, jun., N. H., Beatty, A. V., and Riley, H. P., *Genetics*, **36**, 552 (1951).
[4] Irwin, J. O., *J. Hyg.*, **43**, 121 (1943–44).
[5] Patt, H. M., *Amer. J. Physiol.*, **155**, 388 (1948).
[6] Alper, T., *Rad. Res.*, **5**, 573 (1956).

Reaction of Carbon Monoxide with Evaporated Barium Films

Carbon monoxide is one of the more common residual gases found in radio valves and the like, because carbon and oxygen are both present as impurities in the metals used for electrodes. After these impurities have diffused separately through the metal, they combine at the free surface and are desorbed as carbon monoxide[1]. Wagener[2], Morrison and Zetterstrom[3] and, recently, della Porta[4], have shown that the amount of carbon monoxide which is taken up by a barium getter film is much less than that to be expected if all of the barium reacted. This limitation is so marked that the term 'poisoning' has been used by way of description.

Some recent studies of the oxidation of barium[5,6] have shown that in this case also a protective film about 50 A. thick is formed at temperatures less than 35° C. At higher temperatures, the whole of the barium film reacts with oxygen. The existence of a critical temperature above which an oxide layer ceases to be protective is predicted by Mott's theory of oxidation[7]. The behaviour of barium towards carbon monoxide suggests strongly that the so-called poisoning is because the film of reaction product is protective. It is significant that the thickness of the film in the case of carbon monoxide is about the same as that of the protective film of oxide.

An experimental study of the taking up of carbon monoxide by evaporated barium films (from commercial getters) has been made in this laboratory, to discover whether there is a critical temperature above which the barium is not poisoned by carbon monoxide. The experimental methods and the apparatus used were similar to those for the study of the oxidation of barium[8]. The results obtained are now described briefly.

The critical temperature above which the film of reaction product ceases to be protective has been found to be 80° C. Below this temperature, the thickness of the protective film decreases: expressed as the number of monolayers of absorbed gas, the thickness is about 15 monolayers at 20° C. and 20 monolayers at 60° C., that is, about 50 A. Above the critical temperature of 80° C., barium getter films continue to react until they are used up completely: this is shown by their becoming translucent, although stained brown. This staining, and the

absence of any change in the slight influence of a nearby ionizing electron discharge upon the speed of pumping of the carbon monoxide (condensation coefficient), suggests that the gas molecules (neutral or ionized) are not taken up directly by the barium, but are first dissociated into oxygen and carbon. Thus the reaction is one of oxidation in the presence of carbon, and so the qualitative similarity between the behaviour of barium towards oxygen and carbon monoxide is to be expected.

In some details, there are important differences between the reactions in the two cases. In the case of oxygen, it was found[5] that the first monolayer of oxygen was only taken up if there were nucleation centres in the surface of the barium film. Ordinarily, such centres always exist in the surface of getter films deposited in a fraction of a minute and at pressures greater than 10^{-6} mm. of mercury. Moreover, during the adsorption of the first monolayer of oxygen the speed of pumping increased. In the case of carbon monoxide, the speed of pumping has been found always to decrease during the adsorption of the first monolayer. Furthermore, no nucleation centres are necessary. Once the first monolayer of carbon monoxide has been absorbed, then the film of reaction products grows in a manner which can be explained with the aid of Mott's theory.

A fuller account of this work is being submitted for publication elsewhere.

I wish to thank Mr. B. M. Cox for help with the experimental work, Mr. M. E. Haine for helpful criticism, and Dr. T. E. Allibone, director of the Research Laboratory, Associated Electrical Industries, Ltd., for permission to publish this communication.

R. N. Bloomer

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston, Berkshire.
April 23.

[1] Smithells, C. J., and Ransley, C. E., *Proc. Roy. Soc.*, A, **155**, 195 (1936).
[2] Wagener, S., *Vacuum*, **3**, 11 (1953).
[3] Morrison, J., and Zetterstrom, R. B., *J. App. Phys.*, **26**, 437 (1955).
[4] della Porta, P., *Vacuum*, **4**, 284 (1954) (published Feb. 1957).
[5] Bloomer, R. N. *Nature*, **179**, 493 (1957).
[6] Bloomer, R. N., *Brit. J. App. Phys.* (in the press).
[7] Mott, N. F., *Trans. Farad. Soc.*, **43**, 429 (1947).
[8] Bloomer, R. N., *Brit. J. App. Phys.*, **8**, 40 (1957).

State of Iodine in Sea Water

Water from the upper layers of the ocean contains some 40 μgm./l. of iodine compounds. Sugawara[1] has shown that about half this is iodide, while the remainder is an oxidized form, which he attributes to iodate. We find that various observations are more readily explained on the hypothesis that the oxidized form is principally hypoiodous acid.

(1) The ratio of oxidized form/iodide is about unity[1]. Calculation from thermodynamic data[2] shows this to be close to the ratio that would obtain between hypoiodous acid and iodide when in equilibrium with atmospheric oxygen, water and hydrogen ions at the *p*H of sea water. (2) It has been observed that sea water exposed to iodine-free air loses its iodine compounds[3]; moreover, the iodine content of the atmosphere near the sea[4] rises to 1–2 μgm./m.[3]. Data upon the relevant free energies[2] show that this is about the value to be expected if air is equilibrated with sea water containing its iodine principally as hypoiodous acid and iodide in equal amounts. (The hypoiodous acid and iodide take part in an equilibrium to give a trace of iodine which is volatile.) (3) The ratio of total iodine/chloride is higher in warm, partly enclosed sea areas[5]. This is to be expected from the effect of temperature upon the equilibria mentioned in (1) and (2)[2], which results in a marked increase in the content of volatile iodine molecules when sea water is cooled.

Whereas the hypothesis accounts for these findings, it should be noted that iodate and not hypoiodous acid would be the thermodynamically stable form of oxidized iodine in the sea. However, it seems likely that the rate of iodate formation from hypoiodous acid, a third-order reaction in near-neutral solution[6], will be slow at the very low hypoiodous acid concentrations in sea water. Together with assimilation by powerfully reducing biological material this factor will tend to prevent iodate accumulating in the sea. On the basis of the hypothesis, and given the necessary thermodynamic data, it should be possible to predict the final oxidation states of marine materials which undergo rapid oxidation-reduction reactions with iodide and hypoiodous acid or iodine.

This work and the relevant calculations will be presented in greater detail elsewhere.

T. I. Shaw
L. H. N. Cooper

Marine Biological Association of the United Kingdom,
The Laboratory,
Plymouth.
April 18.

[1] Sugawara, K., Paper read at the Regional Symposium on Physical Oceanography, Tokyo (October 1955).
[2] "International Critical Tables", 1st edit. (1926–33).
[3] Fellenberg, Th. V., *Biochem. Z.*, **152**, 132 (1924).
[4] Heymann, J. A., *Ned. Tijdschr. Geneesk.*, **1**, 640 (1927).
[5] Reith, J. F., *Rec. Trav. Chim. Pays-Bas.*, **49**, 142 (1930).
[6] Skrabal, A., *Mh. Chem.*, **72**, 223 (1939).

Colorimetric Estimation of Manganese

Tetramethyldiaminodiphenylmethane ('tetrabase') has been widely used for the colorimetric estimation of quantities of manganese of the order of 0·01–0·1 μgm.[1–4]. As generally applied, the test involves the addition of tetrabase and potassium periodate in excess to a sodium acetate–acetic acid buffer containing manganese in solution. The intensity of the transient blue colour[1–3]—or more permanent green[4]—so produced is closely related to the concentration of manganese. The nature of the reaction or of its end-products does not appear to have been elucidated, although it is known that manganese hydroxide reacts with tetrabase to produce a blue colour[3], and it has been suggested that in the presence of periodate, manganese acts as a catalyst in the oxidation of tetrabase[3].

In a preliminary study of the reaction it has been found that permanganate and hydrated manganese dioxide are equally effective in the production of the blue colour in the absence of other oxidizing agents. The concentration of manganese necessary to produce unit increase in colour intensity under these conditions is, however, 30–40 times greater than when periodate is present. When manganese and periodate are present in excess, the molar concentration of tetrabase required to produce the same unit increase in intensity is approximately twice that of perman-

ganate or manganese dioxide. The reaction between permanganate and tetrabase is extremely rapid, whereas in the normal application of the test, where periodate is present, colour development may take several minutes. The tetrabase derivative responsible for the blue colour in aqueous medium can be extracted with chloroform. This solution is colourless and contains no manganese. On removal of the chloroform and addition of water, the blue colour reappears.

These results are in agreement with the suggestion that manganese acts in a catalytic role, tetrabase being oxidized by permanganate or manganese dioxide, and the reduced manganese so produced being re-oxidized by periodate. It is probably this latter reaction which determines the rate of colour development. To account for the quantitative nature of the test, it is clear that the reaction must cease after a certain amount of colour has been produced. With periodate and tetrabase in excess this can only be brought about by the loss of manganese from the system.

If the reaction is carried out at temperatures greater than 90° C., little or no colour is observed, although the blue pigment is quite stable to heat. On cooling, the addition of further tetrabase and periodate is ineffective, and additional small amounts of manganese produce colour intensities much less than those expected. Excess of manganese, however, produces the usual intense blue. It is suggested that in the oxidation of tetrabase a second substance in addition to the blue pigment is formed. This is soluble in water and is capable of complexing manganese, which is then lost from the oxidation-reduction cycle. At high temperature this second reaction is favoured, and this accounts for the inverse temperature-colour intensity relation which has been observed[4].

Although the method in routine use is capable of giving duplicate estimates differing by less than 5 per cent, extinction values per unit manganese may show unaccountable variations from day to day. Such variations are often associated with changes in the rate of colour development which, as has been shown, depends on the manganese oxidation cycle. This is strongly affected by the order in which reagents are added. When periodate is added last, the initial phase of colour development is very slow, the intensity/time curve following a markedly sigmoid pattern typical of an autocatalytic reaction. When tetrabase is added last, however, the initial development is rapid, with no early lag phase, and final intensities tend to be higher.

It has been shown that the oxidation of divalent manganese to permanganate in strongly acid solution is autocatalytic[5], and the results here suggest that a similar mechanism may be operating, the presence of a high-valency state of manganese being necessary for the reaction to proceed at maximum rate. It seems likely that this part of the reaction is responsible for many of the troubles which have been experienced with the test and a fuller understanding of the oxidation of manganous ions to permanganate at extremely low concentrations will be necessary if further progress is to be made in the use of the method.

In the course of this study it was observed that water from a 'Permutit' ion-exchange resin column, if used for making up reagents, may interfere seriously with results. This was in spite of the fact that water from the same column had been used successfully for some years previously. It is probable that traces of resin, which have been observed at a concentration of 3 p.p.m. in this water, were the cause of the interference.

W. V. Single*

Research Institute of Plant Physiology,
Imperial College of Science and Technology,
South Kensington,
London, S.W.7.
April 23.

* On leave from the Department of Agriculture, New South Wales.

[1] Nicholas, D. J. D., and Fisher, D. J., Ann. Rep. Long Ashton Res. Sta., 115 (1950).
[2] Harry, R. G., *Chem. and Indust.*, **50**, 796 (1931).
[3] Harvey, H. W., *J. Marine Biol. Assoc. U.K.*, **28**, 155 (1949).
[4] Cornfield, A. H., and Pollard, A. G., *J. Sci. Food Agric.*, **1**, 107 (1950).
[5] Strickland, J. D. H., and Spicer, G., *Anal. Chim. Act.*, **3**, 517 (1949).

Use of Wooden Boxes for Breeding Mice

As a result of a personal communication made to one of us that the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, U.S.A., had reverted to the use of wooden boxes in preference to metal boxes for breeding mice, and had thus restored their previous level of productivity, it was decided to investigate the most suitable pattern of box and its mode of construction.

The box now in regular use at the experimental mouse-breeding unit at Hampstead is made of imported cedar or other suitable hard wood. The internal dimensions are 12 in. long, 8 in. wide and 4½ in. deep. The sides and ends are ⅝ in. thick with mortised joints reinforced by brass pins; and the bottom is ¼ in. thick resin-bonded 3-ply wood also lined up with brass pins. The parts are held together with a phenolformaldehyde resin, and it is this resin, not the pins, that holds the box together. The resin is resistant to both water and heat. Plywood is necessary for the bottom because it does not expand laterally when wet, as does plain board. Warping will only occur if unseasoned wood is used; this, however, is hard to avoid, but we have found that only about one in twenty boxes gives trouble in this way, and then only if too little resin is used.

The lid of the box is of metal with a built-in basket for cubes, and a small bridge to support an inclined 12-oz. medicine-flat type water-bottle with a protected hole for the passage of the drinking-tube. Any preferred pattern of lid can be used with one proviso. The shoe-box type lid with an exterior flange is unsuitable, for it enables the mice to get at the edge of the wood and gnaw their way out. The lid must fit inside the box, the interior flange going down about ½ in.; with such a lid gnawing is prevented.

Wooden boxes that have been in use for two years, being regularly sterilized by steam or boiled in water, are virtually as good as new; their lifetime is not yet known but it is certainly long.

A fuller report is being published elsewhere.

Joyce L. Bloom
W. Lane-Petter
G. Porter

Laboratory Animals Bureau,
Medical Research Council Laboratories,
Holly Hill,
Hampstead,
London, N.W.3.
April 17.

FORTHCOMING EVENT

Wednesday, August 7—Friday, August 9

British Society for Research on Ageing (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 9.30 a.m. daily—Symposium on "The Biology of Hair Growth".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Principal Physicist in the Radiotherapy Department—The Superintendent, Guy's Hospital, London, S.E.1 (August 12).

Senior Lecturer or Assistant Lecturer in the Department of Physics—The Registrar, The University, Manchester (August 12).

Senior Lecturer and a Lecturer in the High Speed Digital Computing Laboratory of the School of Electrical Engineering, New South Wales University of Technology, Sydney, for duties associated with the analysis and programming of problems for the UTECOM computer—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2 (Australia, August 15).

Assistant, Grade B (with a degree in physics, and preferably suitable industrial experience), in Physics—The Principal, Wigan and District Mining and Technical College, Wigan (August 16).

Assistant Lecturer in the field of (*a*) Plant Biochemistry and Nutrition or (*b*) Soil Physics—The Registrar, The University, Nottingham (August 17).

Assistant Lecturer or Lecturer in Electrical Engineering—The Registrar, University College, Singleton Park, Swansea (August 17).

Assistant Lecturer or Lecturer in Physics—The Registrar, The University, Sheffield (August 17).

Assistant Lecturer in Theoretical Physics—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (August 20).

Assistant Lecturer or Lecturer in Veterinary Physiology—The Registrar, The University, Liverpool (August 20).

Lecturer in Geography, with special reference to regional and social geography—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (August 24).

Deputy Librarian at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 31).

Post-Doctoral Fellow in Physical Chemistry, for research work connected with the application of electron magnetic resonance spectroscopy to a study of free radicals—The Deputy Registrar, The University, Edgbaston, Birmingham 15 (August 31).

Research Assistant (honours graduate in chemistry or agricultural chemistry), for research on the chemical and physical properties of expanded vermiculite in relation to its use in agriculture—The Registrar (Room 9 O.R.B.), The University, Reading (August 31).

Senior Lecturer in Mathematics—The Registrar, The University, Stellenbosch, South Africa (August 31).

Lecturer in Geology; and a Lecturer in Pharmacy at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, September 1).

Lecturer (with special qualifications for teaching and research in inorganic chemistry) in Chemistry—The Registrar, The University, Edgbaston, Birmingham 15 (September 1).

Lecturer in Poultry Science in the Faculty of Rural Science—The Acting Registrar, University of New England, Armidale, N.S.W., Australia (September 13).

Chair of Mathematics at the Pietermaritzburg or Durban centres of the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, September 14).

Senior Lecturer or Lecturer (preferably with qualifications in mycology or physiology with special reference to the lower plants) in Botany at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 28).

Senior Lecturer (with an honours degree or higher degree in mechanical engineering) in Mechanical Engineering at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 28).

Professor of Applied Mathematics in the Durham Division of the University—The Registrar, University Office, 46 North Bailey, Durham (September 30).

Senior Lecturer (Clinical) in Tropical Medicine at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

Chair of Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (October 7).

Assistant Lecturers and Lecturers in Engineering in the Departments of Civil, Mechanical, Electrical and Mining Engineering—The Registrar, The University, Nottingham.

Medical Entomologist (with qualifications in entomology and experience in insect and malaria eradication control) with the Government of Jamaica, for duties in connexion with malaria control—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/32/025.

Research Assistant (with an honours degree and some experience of stress analysis and properties of materials) for research into expanding tubes in high pressure boilers—Prof. H. Ford, City and Guilds College, London, S.W.7.

Technician in the Genetics Research Laboratory, to assist in research employing physiological and serological techniques and histology—The Secretary, The University, Old College, South Bridge, Edinburgh.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Aero Research Technical Notes. Bulletin No. 174: Bonding of Laminated Plastics: Post-Forming by V. C. Panels Limited. Pp. 6. (Duxford: Aero Research Limited, 1957.) [107

Annual Report of the Yorkshire Philosophical Society for the year 1956. Pp. 13. (York: Yorkshire Philosophical Society, 1957.) [107

City and County of Bristol. The City Museum—Report of the Committee for the year ended 31 December 1956. Pp. 22+2 plates. (Bristol: The City Museum, 1957.) [107

Code of Practice for the Protection of Persons exposed to Ionizing Radiations. Pp. iv+83. (London: H.M. Stationery Office, 1957.) 8*s.* net. [107

Supplement to a World Dictionary of Breeds, Types and Varieties of Livestock. By I. L. Mason. (Supplement to Technical Communication No. 8 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.) Pp. 52. (Farnham Royal: Commonwealth Agricultural Bureaux, 1957.) 7*s.* 6*d.* [107

Mind and Matter, Vol. 1, No. 1 (June, 1957). A quarterly journal. Pp. 48. Annual subscription rates: 30*s.*; 4.50 dollars. (Oxford: Delawarr Laboratories, 1957.) [107

Tube Investments Limited. Technical Report (June, 1957): Irradiated Polythene Tape. Pp. 8. (London: Tube Investments Limited, 1957.) [107

The North of Scotland College of Agriculture. Calendar, 1957–58. Pp. 242. (Aberdeen: North of Scotland College of Agriculture, 1957.) [117

Other Countries

Colony and Protectorate of Kenya. White Paper No. 85 of 1957: A Forest Policy for Kenya. Pp. 9. (Nairobi: Government Printer, 1957.) [176

University of Helsinki: Institute of Meteorology. Papers. No. 80: A Study of Vertical Velocity Distribution in some Jet Stream Cases Over Western Europe. By Lauri A. Vuorela. Pp. 23. (Reprint of *Geophysica*, Vol. 6, No. 2.) No. 81: A Method for the Direct Recording of Sounding Data on Aerological Diagram Paper: a Preliminary Report. By Vilho Väisälä. Pp. 6. No. 82: A Mixing Hygrostat. By Vilho Väisälä and Seppo Huovila. Pp. 12. (Helsinki: The University Institute of Meteorology, 1957.) [176

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark. Rapports et Procès-Verbaux des Réunions. Vol. 142. 1ere partie: Procès-Verbaux, Octobre, 1956. 2eme partie: Rapport Administratif, 1955. Pp. 51. (Copenhague: Andr. Fred. Høst et Fils, 1957.) Kr. 16. [176

Anais da Academia Brasileira de Ciencias, Vol. 28, No. 4, 1956. Pp. 405–578+xxxiii–1. (Rio de Janeiro: Academia Brasileira de Ciencias, 1956.) [176

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 116, No. 2: A Catalogue of the Cerionidae (Mollusca-Pulmonata). By William J. Clench. Pp. 119–170. Vol. 116, No. 3: Studies on New Zealand Elasmobranchii. Part 6: Two New Species of *Etmopterus* from New Zealand. By J. A. F. Garrick. Pp. 171–190. Vol. 116, No. 4: Biological Investigations in the Selva Lacandona, Chiapas, Mexico. By Raymond A. Paynter, Jr. Pp. 191–298+1 plate. Vol. 116, No. 5: The Genus *Tetragnatha* (Araneae, Argiopidae) in Panama. By Arthur M. Chickering. Pp. 299–354. Vol. 116, No. 6: The *Tenuis* and *Selenophora* Groups of the Ant Genus *Ponera* (Hymenoptera: Formicidae). By Edward O. Wilson. Pp. 355–386. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1957.) [186

Museum of Comparative Zoology at Harvard College. Breviora. No. 74 (May 1, 1957): The Discovery of Cerapachyine Ants on New Caledonia, with the description of New Species of *Phyracaces* and *Sphinctomyrmex*. By E. O. Wilson. Pp. 9. No. 75 (May 1, 1957): On a New Octochaetine Earthworm Supposedly from Guatemala. By G. E. Gates. Pp. 8. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1957.) [186

Trinidad and Tobago. British Caribbean Meteorological Service Annual Report, 1956. Pp. 19. (Trinidad: Government Printing Office, 1957.) [196

Symposium on High Polymers held under the auspices of the National Chemical Laboratory, Poona, and the Plastics Research Committee, from March 2nd to 5th, 1957; and an Exhibition of Products by the Plastics, Rubber and Synthetic Fibre Industries, at the National Chemical Laboratory, Poona. Pp. 32+xl. (Poona: National Chemical Laboratory, 1957.) [206

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £7/10/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2
Telephone Number: Holborn 4743

All rights reserved. Registered as a newspaper at the General Post Office

OPTICAL INSTRUMENTS

A vacancy occurs for a young General Science Graduate, preferably with physics, mathematics and chemistry, for work on the application of improved methods to the manufacture of optical instruments. The post should be of particular interest to a man with a liking for experiment and practical investigation. Candidates should have completed or be exempt from National Service. Five-day week and staff pension scheme in operation.—Apply in writing, stating full particulars of age, education and relevant experience, to The Personnel Officer, Cooke, Troughton and Simms Ltd., Haxby Road, York.

JAMES A. JOBLING & CO. LIMITED, manufacturers of "Pyrex" brand Laboratory, Scientific and oven-table glassware invite applications for the following positions in their Research Laboratories.

1. Analytical Chemist with degree or H.N.C. in chemistry to develop and put into practice modern methods of analysis of glass, some experience of silicate analysis desirable.
2. Physicist with B.Sc. Honours in Physics or good pass B.Sc. with physics as principal subject, for investigation into problems connected with the manufacture and processing of glassware.

Salary will be commensurate with qualifications and experience, contributory pension scheme. Applications should be sent to the Personnel Manager, Wear Glass Works, Sunderland.

WELL-KNOWN BRITISH COMPANY WITH Head Office in London and an extensive organization overseas, wishes to appoint a senior man who, within the framework of the existing sales organization, will supervise and further develop a technical advisory service on a world-wide basis. This appointment, which is an unusually interesting one, offers considerable scope for a person of energy and initiative, involves overseas travel and carries a substantial salary and other benefits. Basic qualifications are an appropriate degree in science, experience in the dissemination of technical advice on the use of insecticides, preferably pyrethrum-based, plus the ability to negotiate successfully at all levels at home and abroad.—Full details of experience and qualifications should be sent to Box JY/116, c/o 95 Bishopsgate, London, E.C.2.

RESEARCH ENGINEER

required to join a group working in the field of vacuum physics. Experience in photoelectrics and electron optics would be advantageous. The post will carry superannuation and there will be ample scope for advancement. Commencing salary will be dependent on age, experience and qualifications. Please apply, giving preliminary details to:

Central Personnel Services,
Marconi House,
336/7 Strand,
LONDON, W.C.2.
quoting reference N.1506J.

BRITISH PLASTER BOARD (HOLDINGS) Ltd., East Leake, near Loughborough, Leics. need Physicists, preferably of Ph.D. standard for basic research and development of technological problems, some experience an advantage but recent graduates considered. The laboratories, which are new, are situated in East Leake, equally convenient for Nottingham or Loughborough. Salaries in accordance with age, qualifications and experience. Non-contributory staff pension scheme.—Write for form of application to Controller of Research, quoting Tech.Phys./KS.

BOOTS PURE DRUG CO. LTD., HAVE vacancies in their Research Department for graduate Biochemists interested in research or development work. For research work candidates should preferably have some postgraduate research experience and subsequent industrial experience would be an additional advantage. The biochemical interests of the company are varied and include the manufacture of antibiotics and biological products. Salary will be in accordance with qualifications, experience and age.—Application, giving full particulars, should be addressed to the Personnel Manager, Boots Pure Drug Co. Ltd., Station Street, Nottingham.

APPOINTMENTS WANTED

UNIVERSITY LECTURER IN CHEMICAL Engineering in mid-thirties seeks alternative post in industry, university or research station, preferably London area. Present salary £1,700.—Box 913, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

GRANTS & SCHOLARSHIPS

UNIVERSITY OF SHEFFIELD

Six Research Bursaries are available in the Department of Fuel Technology and Chemical Engineering for graduates in physics, mathematics, chemistry, chemical engineering, or other engineering subjects, who wish to enter the important field of flames and fuels. The work relates to heat transfer from flames and furnace aerodynamics. Value in the range £300 to £500 per annum plus research fees. Bursars may become candidates for higher degrees of the University.

Applications should be sent to the Registrar as soon as possible.

UNIVERSITY OF HULL
DEPARTMENT OF CHEMISTRY

Applications are invited for a Studentship for research on the pyrolysis of high molecular weight organic compounds and the investigation of the carbons so produced, especially by adsorption techniques. The Studentship will be available for either two or three years and will enable a suitable candidate to proceed to a higher degree.

Forms of application may be obtained from the Registrar. The last date for the return of the completed forms is August 19, 1957.

W. D. CRAIG,
Registrar.

TRADE ANNOUNCEMENTS

GLASS FIBRE FILTER PAPERS (BOROsilicate Glass) from U.S.A.—Send for details to Jencons Ltd., Mark Road, Hemel Hempstead, Herts

RESEARCH OFFICER (AGRICULTURE)—BOTANY

The Civil Service of Canada

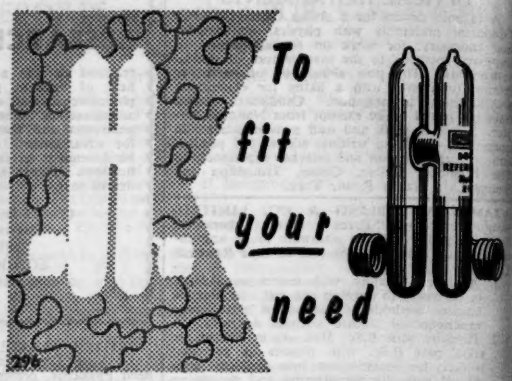
invites applications for a Botanist to be responsible, under direction, for the plant introduction activities of the Arboretum and Botanic Garden, Ottawa, and for undertaking studies on the taxonomy of cultivated plants. Postgraduate training preferably to the doctorate level preferred. Applicants must have had two years of acceptable experience in research and developmental work.

Salary scale, $5580 to $6780 per annum. Excellent provisions for pension, leave and other benefits. For application forms, write to the Department of Labour of the Government of Canada, 61 Green Street, London, W.1, England.

PHOTOMICROGRAPHIC CAMERA for 35 mm. film

Write for full details of our extensive range of Photomicrographic Apparatus

R. & J. BECK LTD.
69/71 MORTIMER STREET, LONDON, W.1

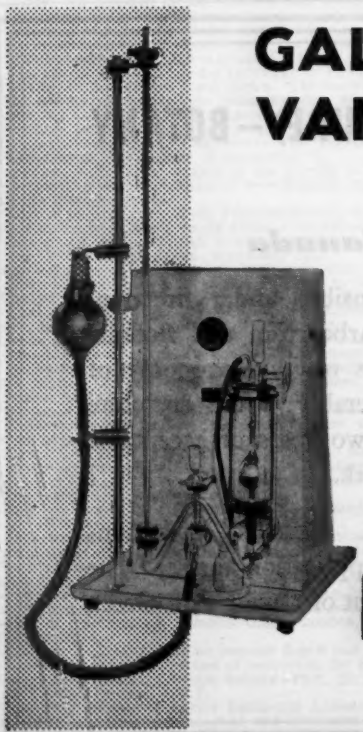


D-845 INDUSTRIAL WESTON REFERENCE CELLS

Use Muirhead D-845 Reference Cells. Reproducible, tough and reliable. Automation and other scientific applications require voltage standards which stay put. D-845 cells remain unaffected by ambient temperature changes. Voltage variation is less than 3 millionths of a volt per °F over an ambient range of at least 40-100°F.

MUIRHEAD

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND
PRECISION ELECTRICAL INSTRUMENT MAKERS
Phone: Beckenham 0041. *Telegrams & Cables:* MUIRHEAD, BECKENHAM



GALLENKAMP *Improved*
VAN SLYKE APPARATUS

- ★ Easy operation
- ★ Quiet shaking
- ★ Fast running at constant speed
- ★ Easily dismantled; glass parts held by adjustable clamps well clear of stand
- ★ Knurled-headed screws on all mounting clamps
- ★ Only standard sizes of glassware used; ready replacement
- ★ Large stopcocks give efficient control and retain lubricant.
- ★ Accessible for cleaning and re-greasing
- ★ Spherical joint to manometer makes stripping, cleaning and remounting of manifold safe and easy
- ★ No mercury seals required
- ★ Rust-proofed metal stand; smart appearance
- ★ Large mercury tray with easy-clean surface

Write for Publication No. 579

GALLENKAMP

A. GALLENKAMP & Co. Ltd., Sun St., London, E.C.2
Telephone: Bishopsgate 0651 (9 lines)
Telegrams: Gallenkamp, Stock, London.

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and ST. MARTIN'S PRESS, INC., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, August 3, 1957.